Enterprise Information System (EIS) Value Assurance Framework (VAF) Risk-Reward Optimization

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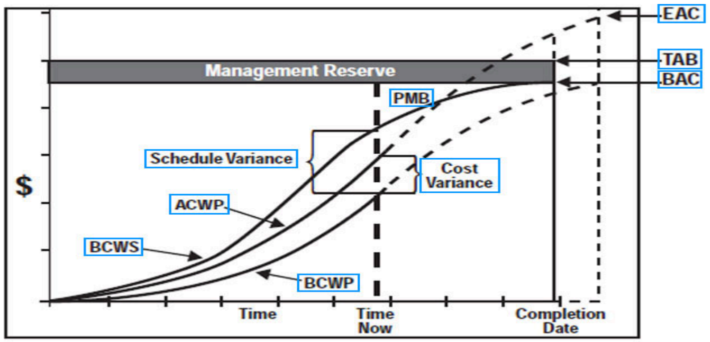
In support of OUSD(I)

Click to LOOK INSIDE!
Eating the IT Elephant
Moving from Greenfield Development to Brownfield
Moore's Law - 2005
Transistors Per Die
1965 Data (Moore)
Memory
Microprocessor
Itanium™ 2 Processor
Itanium™ Processor
Pentium® 4 Processor
Pentium® III Processor
Pentium® II Processor
Pentium® Processor
486™ Processor
386™ Processor
Source: Intel
ANNIVERSARY EDITION WITH FOUR NEW CHAPTERS
No Silver Bullet
Essence and Accidents of Software Engineering
Frederick P. Brooks, Jr.
University of North Carolina at Chapel Hill
THE MYTHICAL MAN-MONTH
FREDERICK P. BROOKS, JR.
INCOSE
SYSTEMS ENGINEERING HANDBOOK
A GUIDE FOR SYSTEM LIFE CYCLE PROCESSES AND ACTIVITIES
THE PHYSICS OF WALL STREET
A Brief History of Predicting the Unpredictable
JAMES OWEN WEATHERALL
Technology Trigger
Peak of Inflated Expectations
Trough of Disillusionment
Slope of Enlightenment
Plateau of Productivity
time
As of July 2012
Plateau will be reached in:
less than 2 years
2 to 5 years
5 to 10 years
more than 10 years
obsolete before plateau
Gamification
Big Data
Crowdsourcing
Internet of Things
Mobile Robots
3D Scanners
3D Bioprinting
Application Stores
Augmented Reality
In-Memory Database Management Systems
Activity Streams
NFC Payment
Audio Mining/Speech Analytics
Cloud Computing
Machine-to-Machine Communication Services
Mesh Networks: Sensor
Gesture Control
In-Memory Analytics
Text Analytics
Home Health Monitoring
Hosted Virtual Desktops
Virtual Worlds
Media Tablets
Mobile OTA Payment
Consumerization
Biometric Authentication Methods
Idea Management
Consumer Telematics
Speech Recognition
Predictive Analytics
MIL-STD-498
5 December 1994
(PDF version)
Superseding
DOD-STD-2167A
29 February 1988
DOD-STD-7935A
31 October 1988
DOD-STD-1703(NS)
12 February 1987
MILITARY STANDARD
SOFTWARE DEVELOPMENT AND DOCUMENTATION
DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA
AMSC NO. N7069
AREA: IPSC/MCCR
GAO
United States Government Accountability Office
Report to Congressional Committees
January 2006
DEFENSE ACQUISITIONS
DOD Management Approach and Processes Not Well-Suited to Support Development of Global Information Grid
GAO
Accountability * Integrity * Reliability
GAO-06-211
The Innovator's Dilemma
When New Technologies
CLAYTON
WHEN HUMANS TRANSCEND BIOLOGY
THE SINGULARITY IS NEAR
RAY KURZWEIL
BusinessWeek
THE MAN WHO INVENTED MANAGEMENT
Why Peter Drucker's ideas still matter

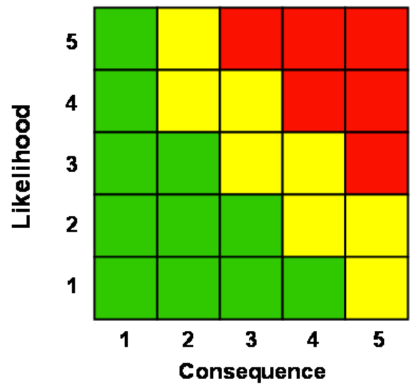
BLUF

- Large “SW engineering” projects fail at greater rates than other engineering projects.
- Risk management strategy is at fault … by definition
- Volatility in IT evolution is closer to volatility in financial markets than engineering regimes. Risk model should follow
  - Focus on reward, i.e. RoI = MOE/MOP
  - Hedge against risk…vice controlling it.
- Peg EIS RoI to Moore’s Law (analogous to pegging financial investments to market.)
  - Self fulfilling prophecy
  - Mathematically optimize risk-reward Open System value proposition
    - “WBS” considers work hours as units of investment in capability modules
    - Agile “IMS” highlights parallel risk-reward-optimization tasks
    - “Earned Value”= V&V confirmation of targeted MOP/MOE
    - Test Plan measures or models correlation across acquisition “investments,” Moore’s Law, and RoI = MOE/MOP
- Plug Fest ecosystem can provide platform

Defense Acquisition Goal is to "Comply" and Avoid Risks?



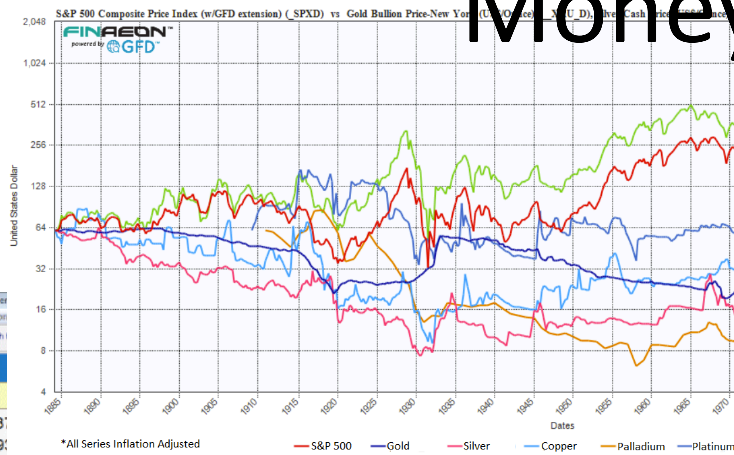
2	Low Likelihood	≈ 30%
3	Likely	≈ 50%
4	Highly Likely	≈ 70%
5	Near Certainty	≈ 90%

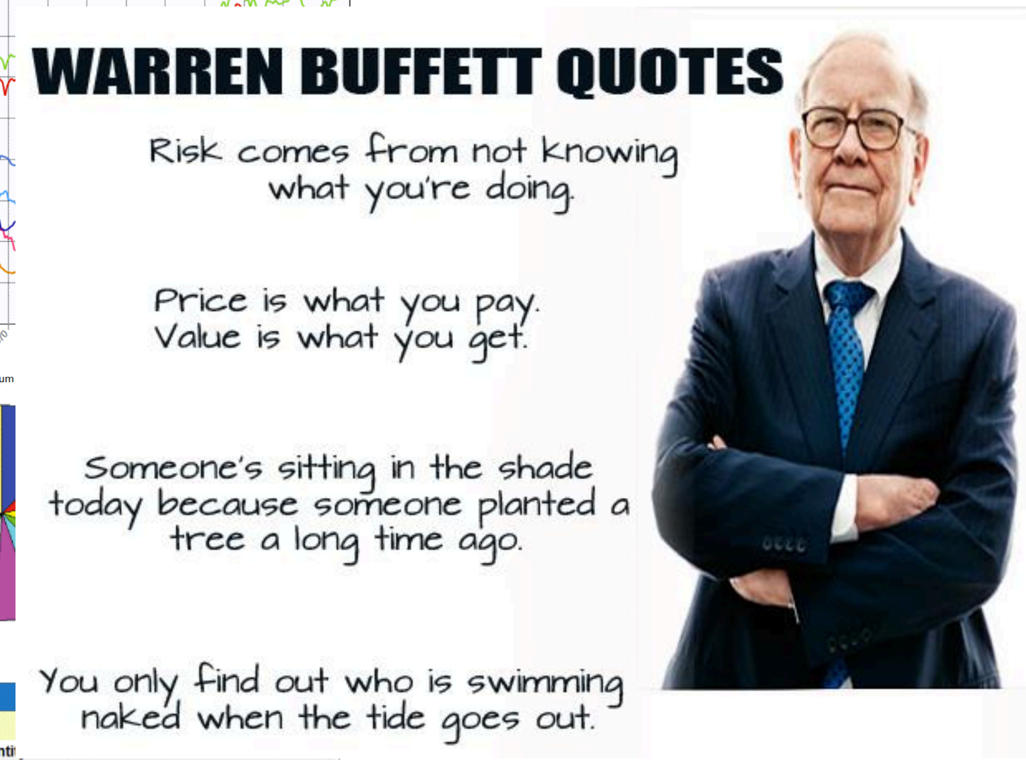


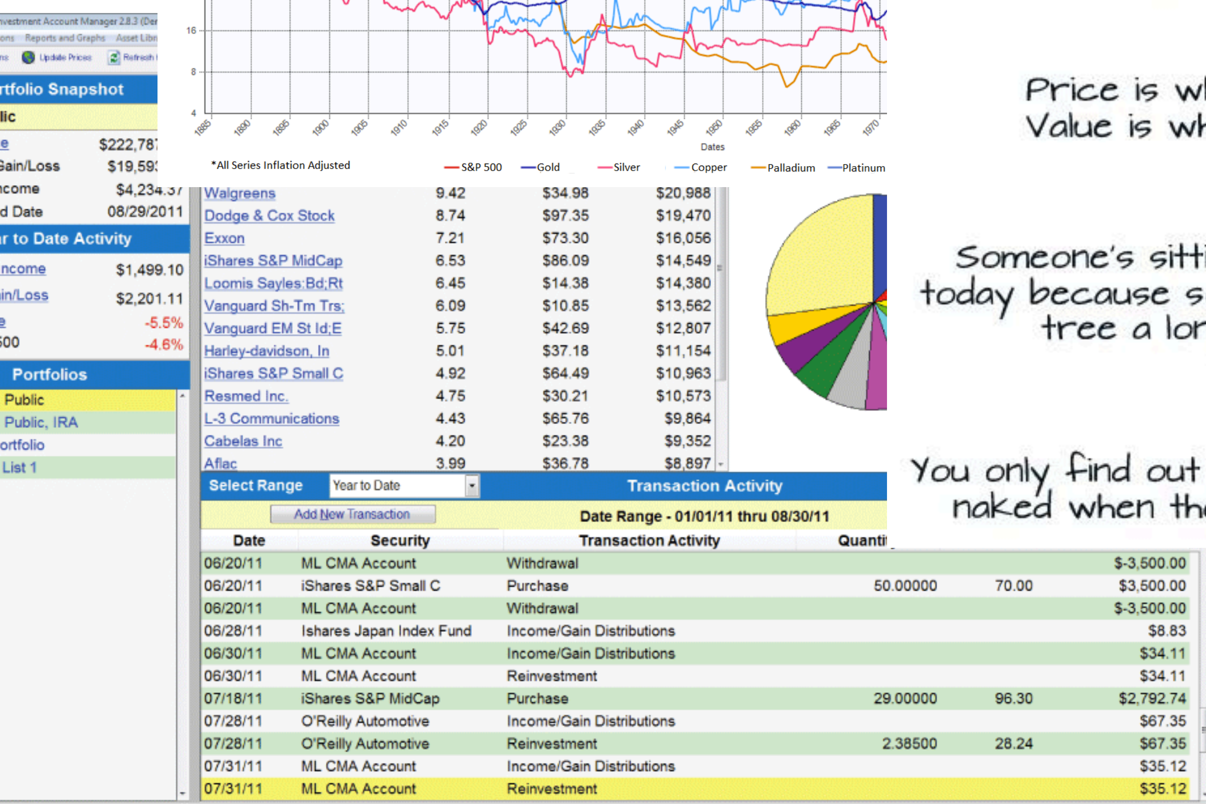
Consequences

Level	Technical Performance	Schedule	Cost
1	Minimal or no impact	Minimal or no impact	Minimal or no impact
2	Minor reduction in performance	< 1 month sched. slip	< 1% cost increase
3	Moderate reduction in performance	1-2 months sched. slip	1-4% cost increase
4	Significant degradation in performance	3-5 months sched. slip	5-9% cost increase
5	Severe degradation in performance; will not meet key technical thresholds	≥ 6 months sched. slip	≥ 10% cost increase

Financial Management Goal is to Predict Risks and Make Money






nvestment Account Manager 2.8.3 (De
ons Reports and Graphs Asset Libr
Update Prices Refresh

rtfolio Snapshot

lic

e	$222,78
ain/Loss	$19,59
ncome	$4,234.37
d Date	08/29/2011

r to Date Activity

ncome	$1,499.10
in/Loss	$2,201.11
e	-5.5%
00	-4.6%

Portfolios

- Public
- Public, IRA
- ortfolio
- List 1

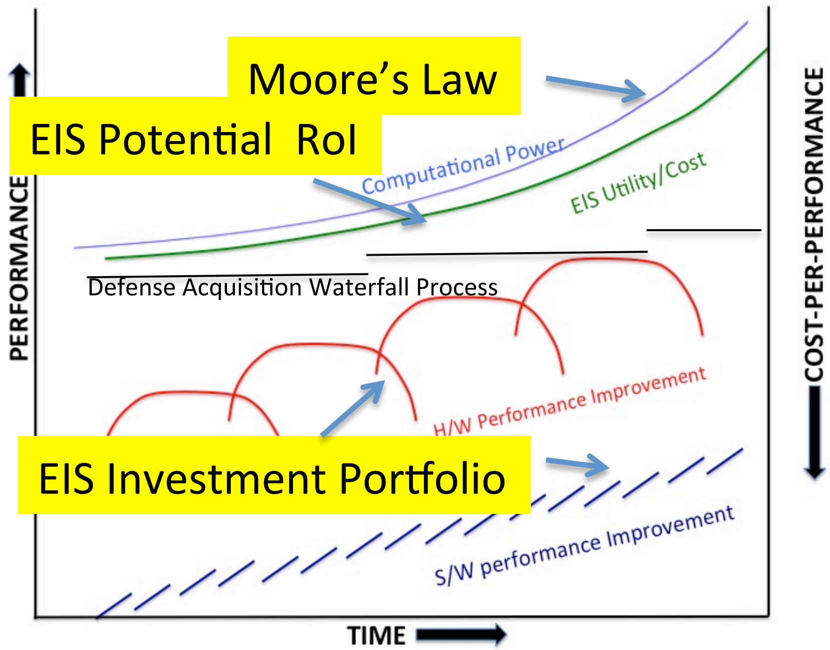
Walgreens	9.42	$34.98	$20,988
Dodge & Cox Stock	8.74	$97.35	$19,470
Exxon	7.21	$73.30	$16,056
iShares S&P MidCap	6.53	$86.09	$14,549
Loomis Sayles:Bd;Rt	6.45	$14.38	$14,380
Vanguard Sh-Tm Trs;	6.09	$10.85	$13,562
Vanguard EM St Id;E	5.75	$42.69	$12,807
Harley-davidson, In	5.01	$37.18	$11,154
iShares S&P Small C	4.92	$64.49	$10,963
Resmed Inc.	4.75	$30.21	$10,573
L-3 Communications	4.43	$65.76	$9,864
Cabelas Inc	4.20	$23.38	$9,352
Aflac	3.99	$36.78	$8,897

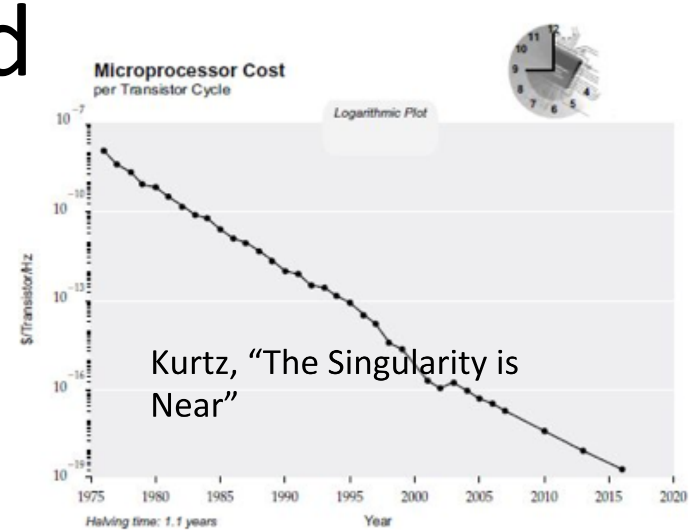
Select Range: Year to Date — Transaction Activity

Add New Transaction — Date Range - 01/01/11 thru 08/30/11

Date	Security	Transaction Activity	Quanti		
06/20/11	ML CMA Account	Withdrawal			$-3,500.00
06/20/11	iShares S&P Small C	Purchase	50.00000	70.00	$3,500.00
06/20/11	ML CMA Account	Withdrawal			$-3,500.00
06/28/11	Ishares Japan Index Fund	Income/Gain Distributions			$8.83
06/30/11	ML CMA Account	Income/Gain Distributions			$34.11
06/30/11	ML CMA Account	Reinvestment			$34.11
07/18/11	iShares S&P MidCap	Purchase	29.00000	96.30	$2,792.74
07/28/11	O'Reilly Automotive	Income/Gain Distributions			$67.35
07/28/11	O'Reilly Automotive	Reinvestment	2.38500	28.24	$67.35
07/31/11	ML CMA Account	Income/Gain Distributions			$35.12
07/31/11	ML CMA Account	Reinvestment			$35.12

VAF Goal is to Optimize Risk/ Reward and Beat the Bad Guys





Kurtz, "The Singularity is Near"

Moore's Law = $P = P_0 e^{kt}$

Corollaries:

- Cost per P decreases exponentially
- COTS-utility-per-cost increases exponentially
- *Bad guys get to use COTS!*

VAF Value Proposition:

u = utility, i.e. ability to satisfy system performance or mission effectiveness KPPs

c = monetary lifecycle costs for EIS or components thereof

t_d = calendar time for one increment of development

V = value = RoI = $u/c \times 1/t_d$

V_p = potential value = $(u_0/c_0)e^{kt} \times 1/t_d$

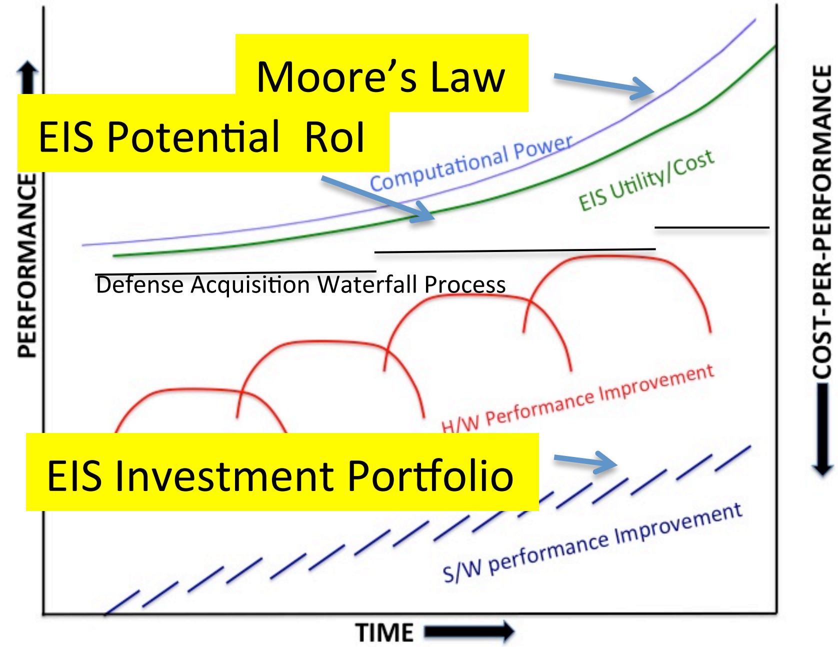
EIS RoI = Measurable Mission Impact!

Measures of Effectiveness:

- Probabilities of achieving desired outcomes
- Task cycle time
- Numbers of good or bad things that happen
- Proficiency scores
- Etc,

Measures of Performance:

- Latencies
- Reliability, Availability, and Maintainability (RAM)
- Lifecycle cost
- Standard compliance
- Security
- Capacity
- Precision
- Size weight and power
- Etc,



$$\frac{\sigma_{(u/c,Pe^{kt})}}{\sigma_{(u/c)}\ \sigma_{(Pe^{kt})}} > 0 \Rightarrow 1$$

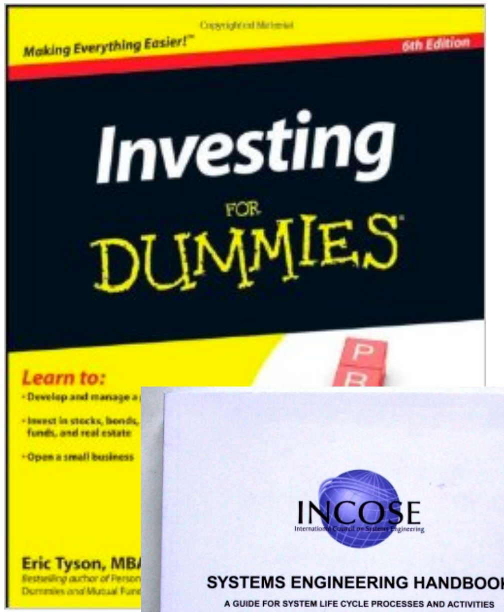
$$\frac{\sigma_{(MOE,MOP)}}{\sigma_{(MOE)}\ \sigma_{(MOP)}} > 0 \Rightarrow 1$$

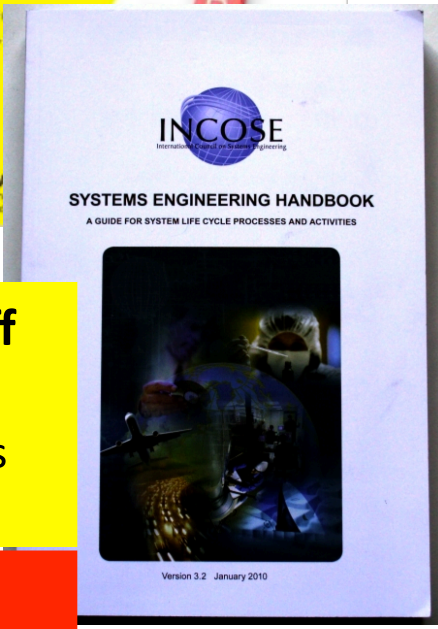
Earning Value = Continuing V&V Assurance that Utility-per-Cost-per-Time Increases in Step with Moore's Law

"Availability of Value" $\propto$ Probability of RoI

$$P[V] \propto A_V = \frac{(R_T - R_W)}{R_T}$$

A_v = availability of valued outcome
R_T = total resources
R_W = wasted resources



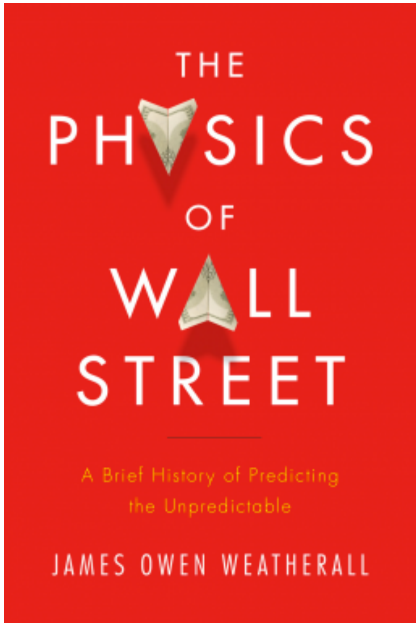


Safe and Wise Investments
- Bundling lifecycle supported COTS/GOTS
- Contractors with good Open System prior performance
- Mature technologies
- Feedback from the customers
- Frequent V&V, T&E
- Coordination with certifiers
- Rigorous, but agile project management practices

Risky, Potentially High Pay Off Investments
- RoI-focus on new technologies
- New collaborators

Dumb Investments
- New technology because it is new
- Contractors without good Open System prior performance
- Long development cycles
- Power Point engineering
- Excessive paperwork

Mathematically Optimize Risk And Reward



$$P[V_t] = P[c_t] \times P[u_t] \times P[s_t]$$

$P[V_t]$ = Probability of achieving threshold level of valued outcome, i.e. RoI.
$P[c_t]$ = Probability of satisfying threshold level of monetary budget requirements.
$P[u_t]$ = Probability of achieving threshold level of utility requirements.
$P[s_t]$ = Probability of achieving threshold level of schedule requirements.

VAF WBS work units are investments (as in a financial portfolio) in

- COTS market survey and AoA
- Outreach to other government projects
- Customer outreach
- Independent capability modules
- Bundling
- Inventing gap closing technology
- V&V, T&E, Certification

VAF Scheduling

- Agile short developmental increments
- Parallel activity across WBS activities above

VAF Earned *Value* (EV)

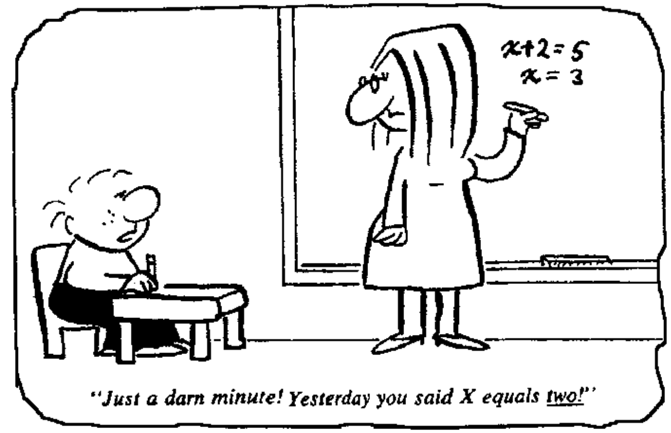
- Each budget/schedule increment must achieve RoI-based, V&V exit criteria

VAF Test Plans

- Objective, incremental V&V of accrual of value throughout EIS lifecycle.
- Tightly coupled to WBS, schedule, and EV
- Mathematically measure/model correlation across Moore's Law, leading MOP, and lagging MOE

Probability of Achieving Threshold Cost

$$P[c_t] \propto \left(A_{ce} = \frac{C_e - \sigma_{ce}}{C_e}\right)$$



$$\sigma_{ce} = \sqrt{(c_a - c_e)^2_{\substack{\text{Upfront}\\ \text{investments}}} + (c_a - c_e)^2_{\substack{\text{Developmental}\\ \text{Test and Cert costs}}} + (c_a - c_e)^2_{\substack{\text{Maintenance}\\ \text{and Upgrade costs}}}}$$

$P[c_t]$ = Probability of achieving threshold requirement for cost

A_{ce} = Availability of cost efficiency

C_e = Previously estimated total EIS lifecycle costs including upfront costs for infrastructure and initial purchases, engineering costs, and lifecycle upgrade and maintenance costs.

σ_{ce} = Root mean square error of actual lifecycle costs vs. estimated costs

c_a = Actual costs for the $)_{\text{indicated}}$ activity

c_e = Previously estimated costs for the $)_{\text{indicated}}$ activity

Probability of Achieving Threshold Utility = "Performance"

$\sqrt{-1}\quad 2^3\quad \Sigma\quad \pi$

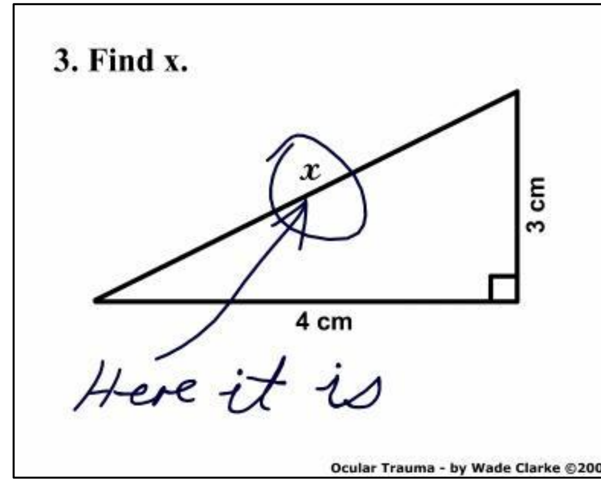
and it was delicious!

$$P[u_t] \propto \left(A_{ca} = \frac{t_d - \sigma_{ca}}{t_d}\right)$$

$$\sigma_{ca} = \sqrt{(t_a - t_s)^2_{test} + (t_a - t_s)^2_{\substack{customer\\feedback}} + (t_a - t_s)^2_{\substack{develop\\new\ tech}} + (t_a - t_s)^2_{\substack{market\\outreach}} + (t_a - t_s)^2_{\substack{other\ critical\\activitiy}}}$$

A_{ca} = Availability of critical scheduled activities
t_d = Originally scheduled time for designing, engineering, T&E, and certification of an incremental EIS capability delivery.
σ_{ca} = Root mean square error of actual time spent on critical risk-reward optimization activities compared to originally scheduled time for those activities.
t_a = Time actually spent performing the $)_{indicated}$ activity
t_s = Time originally scheduled for the $)_{indicated}$ activity

Probability of Achieving Threshold Schedule



$$P\,[s_t] \propto \left(A_{dv} = \frac{\sum_{n=1}^{f} K_n(Wf_n)}{\sum_{n=1}^{p} K_n(Wp_n)}\right)$$

$P[s_t]$ = Probability of achieving threshold schedule requirements

A_{dv} = Availability of developed value. I.e. weighted sum of completed work units divided by weighted sum of scheduled work units.

Wf_n = Successfully completed work unit. ***Scope of any designated work unit must include objective V&V of that unit as part of its completion criteria. Thus a completed work unit is equivalent to accruing actual measured, or robustly modeled, value.***

Wf_n = Scheduled work unit.

K_n = Weighting factor. Weighting should take into account a clear delineation of how any work unit relates to project critical path.

n = Counting index

f = Number of successfully completed and tested scheduled work units.

p = Number of scheduled work units.

VAF Risk/Reward Matrix

Likelihood Rationale*:

5. Almost Certain
4. Probable
3. 50/50
2. Improbable
1. Almost No Chance

$$P[V_t] = P[c_t] \times P[u_t] \times P[s_t]$$

Positive Consequences

Probability of negative consequence	Maximal 5	Major 4	Moderate 3	Minor 2	Minimal 1	Probability of positive consequence
5 80-100%	5,5	10,4	15,3	20,2	25,1	1 0-20%
4 61-80%	4,10	8,8	12,6	16,4	20,2	2 21-40%
3 41-60%	3,15	6,12	9,9	12,6	15,3	3 41-60%
2 21-40%	2,20	4,16	6,12	8,8	10,4	4 61-80%
1 0-20%	1,25	2,20	3,15	4,10	5,5	5 80-100%
	1 Minimal	2 Minor	3 Moderate	4 Major	5 Maximal	

Negative Consequence

Risk factor = (magnitude of neg consequence) X (probability of occurrence)

Reward factor = (magnitude of pos consequence) X (probability of occurrence)

Consequence Rationale*:

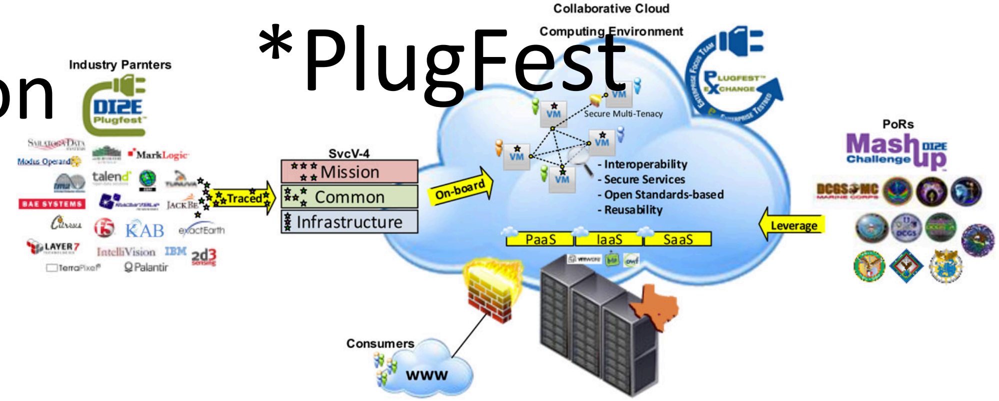
5. Risk: >= 100% degradation* /Reward: >= 100% improvement*
4. +/- 80%
3. +/- 60%
2. +/- 40%
1. Risk <= 20% degradation/Reward: <= 20% improvement

$$RoI = u/c \times 1/t_d$$

*Mathematically Measured/ Modeled Impact to Cost, Performance (u~MOE/MOP), and/or Schedule

Risk-Reward Optimization Factors and Metrics

*PlugFest



R_O = Ability to continuously capture evolving the operational customers' perception of value within rapidly evolving operational domains (e.g. by designating specific operational "beta users" and establishing continuous feedback loop.)

→ Customer Contact Hours*

R_T = Ability to continuously harvest technological value in rapidly evolving technological domains (e.g. by applying best commercial practices for open standard product line architecture, and conducting test and certification in parallel to development.)

→ Bundling time*

$R_\$$ = Ability to predict lifecycle costs for continuously evolving capability (e.g. by heavily leveraging existing off-the-shelf technologies that come with well established life cycle tech refresh cost models.)

→ Known lifecycle costs*

R_{IA} = Ability to balance the need-to-protect information and EIS network resources with the need-to-share them across security domains (e.g. by working with customers to define need-to-share and need-to-protect policies and implementing them with high assurance virtual technology.)

→ Demo "PL4" dynamic need-to-share policy*

R_{VI} = Ability to find and deliver valued information bits within tightly constrained decision windows, given large and growing backdrop of available information bits (e.g. by working with customers to identify critical conditions of interest and associated threshold values and implementing automated "smart push" alerts.)

→ Compress info processing cycle time*

R_{PS} = Availability of professional skills required for rapid evolutionary development (e.g. by performing careful due diligence of vendors prior performance against similar open standard EIS projects.)

→ Contractor prior performance re OSA*

VAF Risk/Reward Matrix

RoI = u/c X 1/t_d

Incremental V&V Shows +/- RoI Trends

P[V_t] = P[c_t] X P[u_t] X P[s_t]

Incremental P[V] Calculation Determines Probability of Consequence

RISK, REWARD

Positive Consequences

Probability of negative consequence	Maximal 5	Major 4	Moderate 3	Minor 2	Minimal 1	Probability of positive consequence
5 81-100%	5,5	10,4	15,3	2[illegible]	25,1	1 0-20%
4 61-80%	4,10	8,8	12,6	16,4	20,2	2 21-40%
3 41-60%	3,15	6,12	9,9	12,6	15,3	3 41-60%
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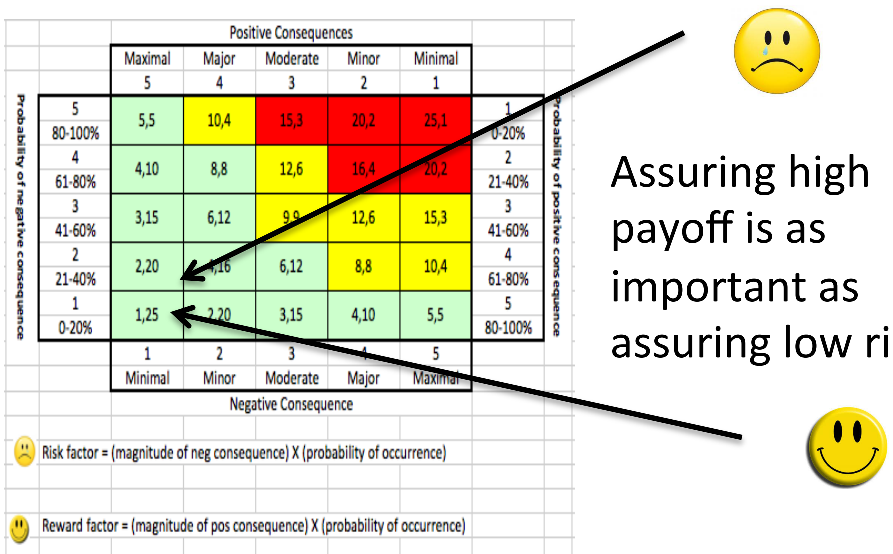
Negative Consequence

Risk factor = (magnitude of neg consequence) X (probability of occurrence)

Reward factor = (magnitude of pos consequence) X (probability of occurrence)

Sample VAF Risk/Reward Strategy



Probability of negative consequence	Positive Consequences: Maximal 5	Major 4	Moderate 3	Minor 2	Minimal 1	Probability of positive consequence
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Negative Consequence	1 Minimal	2 Minor	3 Moderate	4 Major	5 Maximal	

Risk factor = (magnitude of neg consequence) X (probability of occurrence)

Reward factor = (magnitude of pos consequence) X (probability of occurrence)

Assuring high payoff is as important as assuring low risk

$P[V_t] = P[c_t] \text{ X } P[u_t] \text{ X } P[s_t]$

$RoI = u/c \text{ X } 1/t_d$

Likelihood Rationale:
5. Almost Certain
4. Probable
3. 50/50
2. Improbable
1. Almost No Chance

Consequence Rationale:
5. Risk: >= 100% degradation* /Reward: >= 100% improvement*
4. +/- 80%
3. +/- 60%
2. +/- 40%
1. Risk <= 20% degradation/Reward: <= 20% improvement

Target technologies/processes with high reward potential
- Operators Identify critical mission threads and associated desired outcomes up front
- Establish associated testable Measures of Effectiveness (MOE) lag metrics
- Establish Measures of Performance (MOP) lead metrics that are testably coupled to MOE lag metrics
- Build iterative test plan that assures MOP lead metrics and MOE lag metrics
- Perform AoA of potential technology components per the above

Target technology portfolio with balanced risk profile
- At least 80% of technology components must exist as COTS/ GOTS*
- Any developed technology has known transition path to COTS/GOTS
- All performers have prior success with Open System development
- Project scope and process must support technology onboarding within "Moore's Law" time window

*COTS/GOTS= configurable out of the box via open standards and comes with known intellectual property rights and life cycle support model

Summary of VAF vs. Traditional Project Risk Management

- The objective of any acquisition is to optimize delivered Value = Utility (U)-per-Time (T)-per-Cost (C) across the capability lifecycle.
- U,T, and C are variables that are dependent on each other. E.g.:
  - Utility of Information Technology(IT) usually decreases rapidly with time
  - Cost is usually directly correlated to the time it takes to develop a solution and the time the solution has been on the market
- Likewise, risk and reward are co-dependent. E.g. useful consideration of risk requires the context of associated potential for reward.
- Contrary to the above, traditional PM risk management approaches:
  - Assume that contract deliverables represent value, and that this value is constant.
  - Address risk and risk mitigation without considering dependence on reward
- In contrast to traditional risk management approaches, VAF:
  - Objectively quantifies targeted value as a variable that is highly dependent on utility, time and cost
  - Probabilistically optimizes risk and reward as co-dependent variables

VAF EIS Risk/Reward Optimization Detail

VAF Risk/Reward Hypothesis

Risk/Reward Statement

- Risk = Description of bad consequence that is reasonably likely to occur, and that can be mitigated with positive actions
- Reward = Description of good consequence that is reasonably likely to occur, and that can be made more likely with positive actions.
- Risk and reward statements should be co-dependent, i.e. risk and reward optimization actions are the same or closely related

Assumptions and Boundary Conditions (BC):

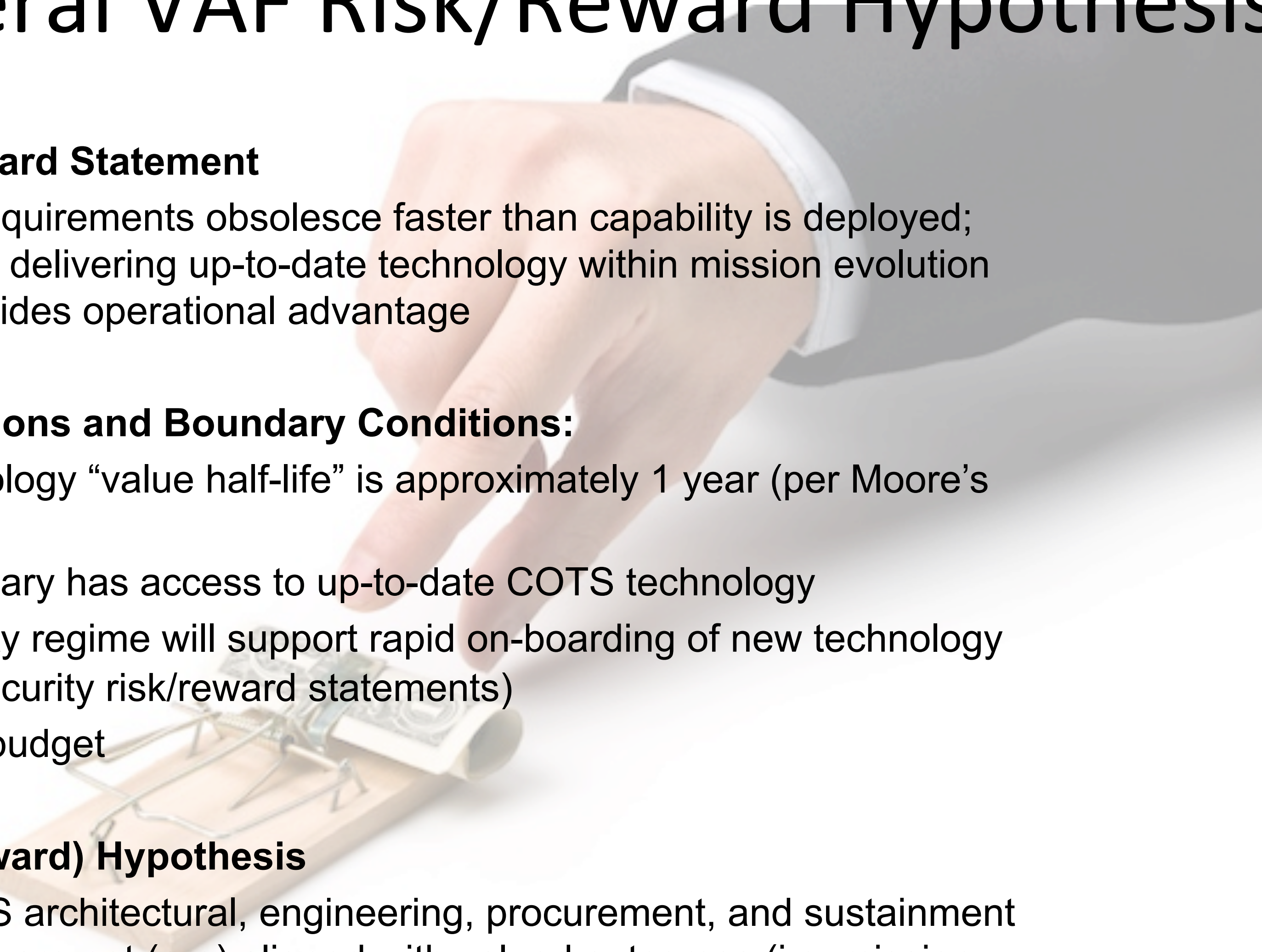
- Assumptions and BCs are descriptions of facts of life that constrain both risk and reward
- Governance policies are almost always BCs for EIS projects; i.e., projects must comply with, or waive, policy.
  - Policy compliance in-and-of-itself is not a reward.
  - Intended policy outcomes may or may not align with desired project outcomes.
- Given the rapid evolution of IT, the perishability of the value of any particular IT stack is almost always a critical BC for EIS projects.
- The specific security regime is almost always a critical BC for EIS projects.

Risk/Reward Hypothesis

If: Positive action is not taken; **Then**: Bad consequence (risk statement) will occur

If: Positive action is taken; **Then**: Good consequence (reward statement) will occur

General VAF Risk/Reward Hypothesis



Risk/Reward Statement

Risk = Requirements obsolesce faster than capability is deployed;
Reward = delivering up-to-date technology within mission evolution cycle provides operational advantage

Assumptions and Boundary Conditions:

- Technology “value half-life” is approximately 1 year (per Moore’s Law)
- Adversary has access to up-to-date COTS technology
- Security regime will support rapid on-boarding of new technology (see security risk/reward statements)
- Fixed budget

Risk/(Reward) Hypothesis

If: The EIS architectural, engineering, procurement, and sustainment processes are not (are) aligned with valued outcomes (i.e. mission success criteria) and EIS development boundary conditions (e.g. Moore’s law, evolving mission and CONOPS, shrinking budget etc.)

Then: The EIS will not (will) provide competitive advantage.

Example VAF Risk/ Reward Hypothesis

Risk/Reward Statement

Risk = Requirements obsolesce faster than capability is deployed; **Reward** = delivering up-to-date technology within mission evolution cycle provides operational advantage

Assumptions and Boundary Conditions:

- Technology value half life is one year
- Adversary has ready access to up-to-date COTS technology
- Adversary is able to share information and network resources at will
- C&A policy
  - C&A, done intelligently, is necessary and useful
- Project Budget is fixed

Risk Hypothesis: If C&A process precludes new capability being deployed within 3 months of requirements identification; Then technology will be obsolete when deployed, and all time and money wasted.

Reward Hypothesis: If C&A of new capability can inherit controls from pre-certified standard security stack, then C&A can be achieved fast enough to allow new capability to be deployed within 3 months of requirements identification.