SYSTEMS INTEGRATION

Application of a

Methodology for Affordability Maturity Assessment

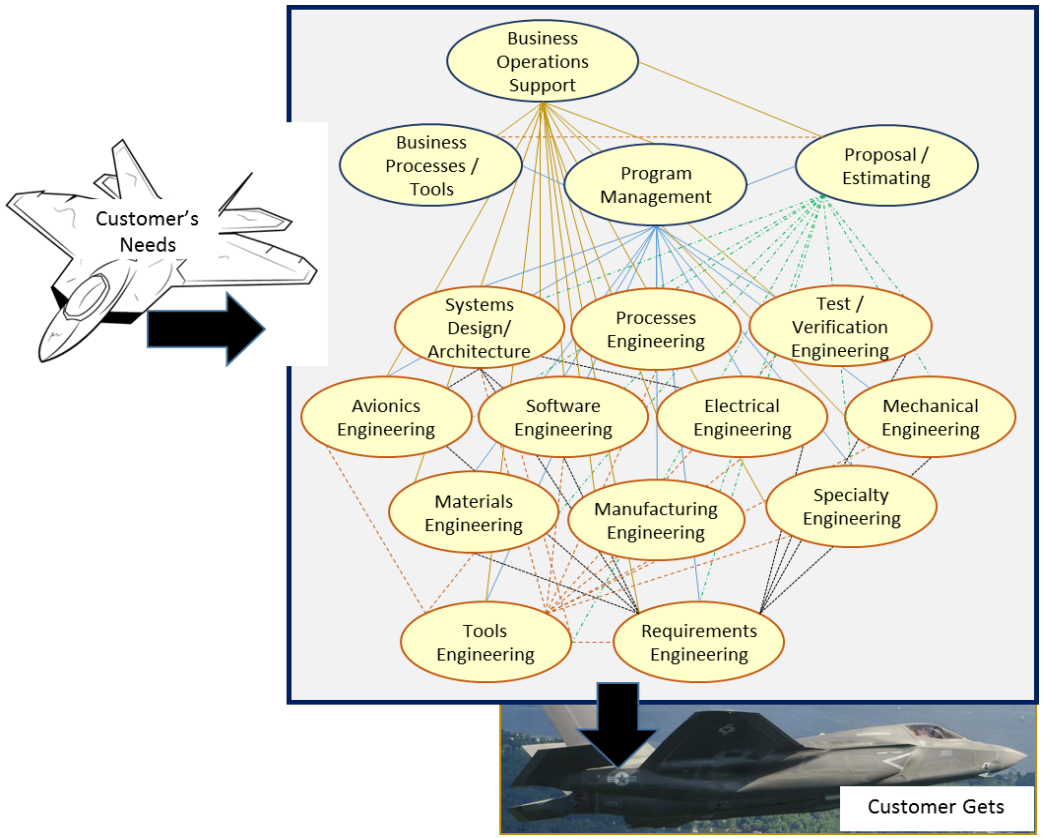
MAY 14, 2019

AGENDA

- **System Integration**
  - ***Synopsis***
  - ***Technical Integration***
  - ***Cost & Schedule Integration***

- **Affordability Maturity Assessment Methodology (AMAM)**
  - ***Recap***
    - OrgCap Model
    - TechPri Model
    - CoSh Model
  - ***AMAM Application***

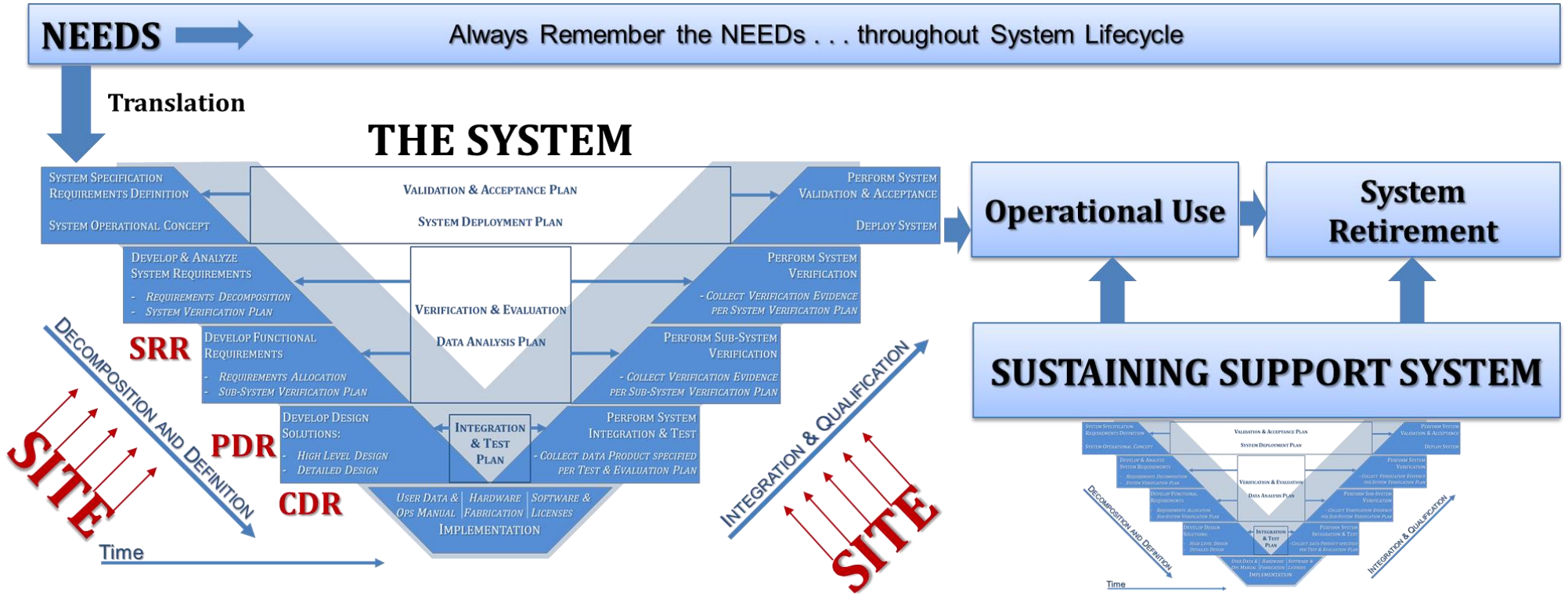
Synopsis



- **CUSTOMERS:**
  - Primary stakeholders of a system's objectives.
- **ENGINEERS OF SOS:**
  - Plan, analyze, organize, and integrate the capabilities of a mix of existing and new systems into an SoS capability
  - Translate customer's needs into verifiable requirements, operational mission capabilities; establish agreed-upon constraints and key technical performance measures for all applicable system levels; and design it.
- **PROGRAM MANAGER:**
  - Oversees, manages, and delivers contract specification requirements & capabilities that satisfied the intended system's objectives on time and within budget during the System Development & Demonstration phase.
- **OTHER ENGINEERING FUNCTIONS:**
  - Staffing, Processes, Tools, Facility, IT and Infrastructure, and etc.
- **BUSINESS MANAGEMENT**

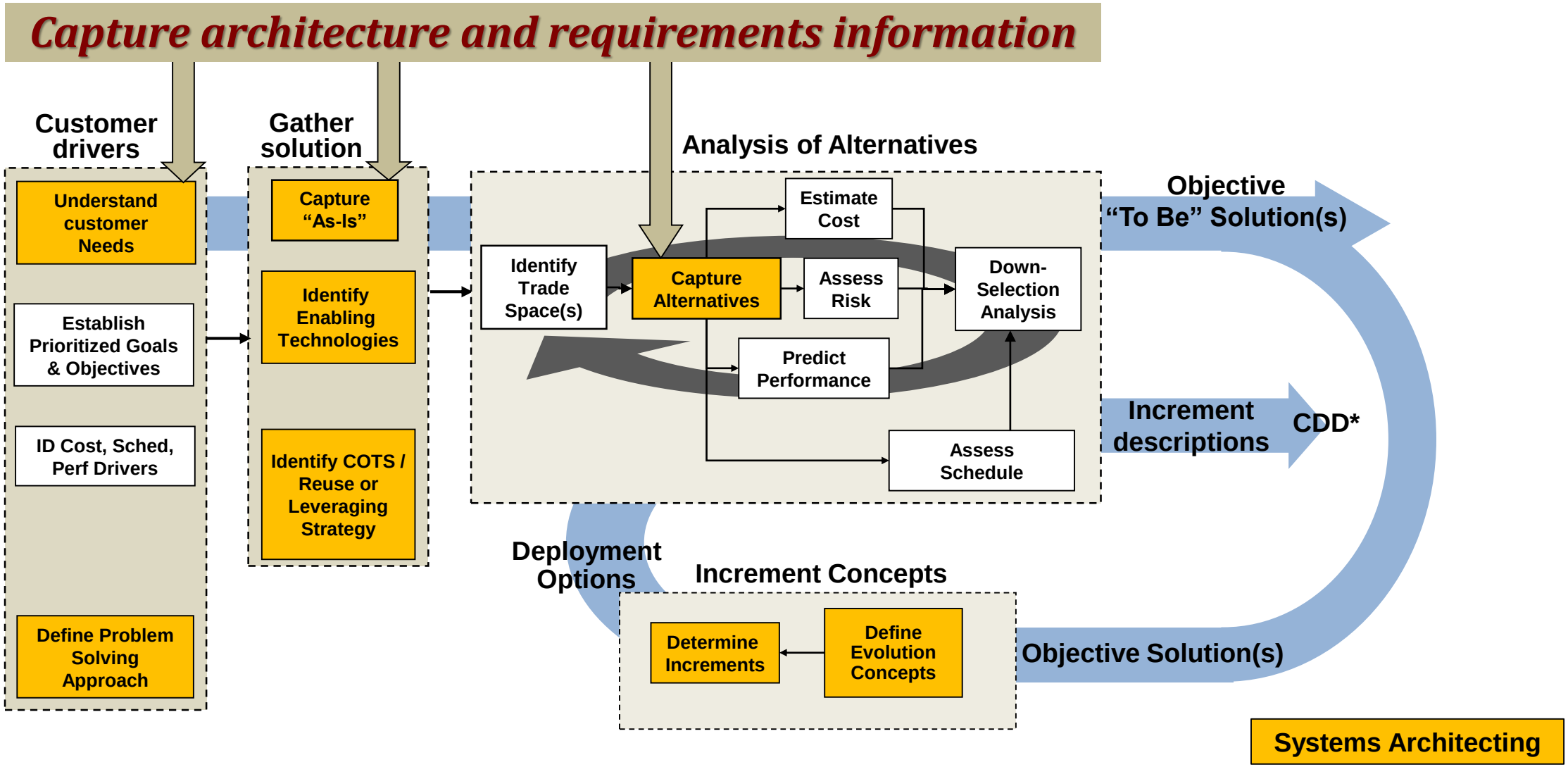
Complexity drives uncertainties and potential cost/schedule increases. **OBJECTIVE: REDUCE COMPLEXITY**

- **Technical Integration**



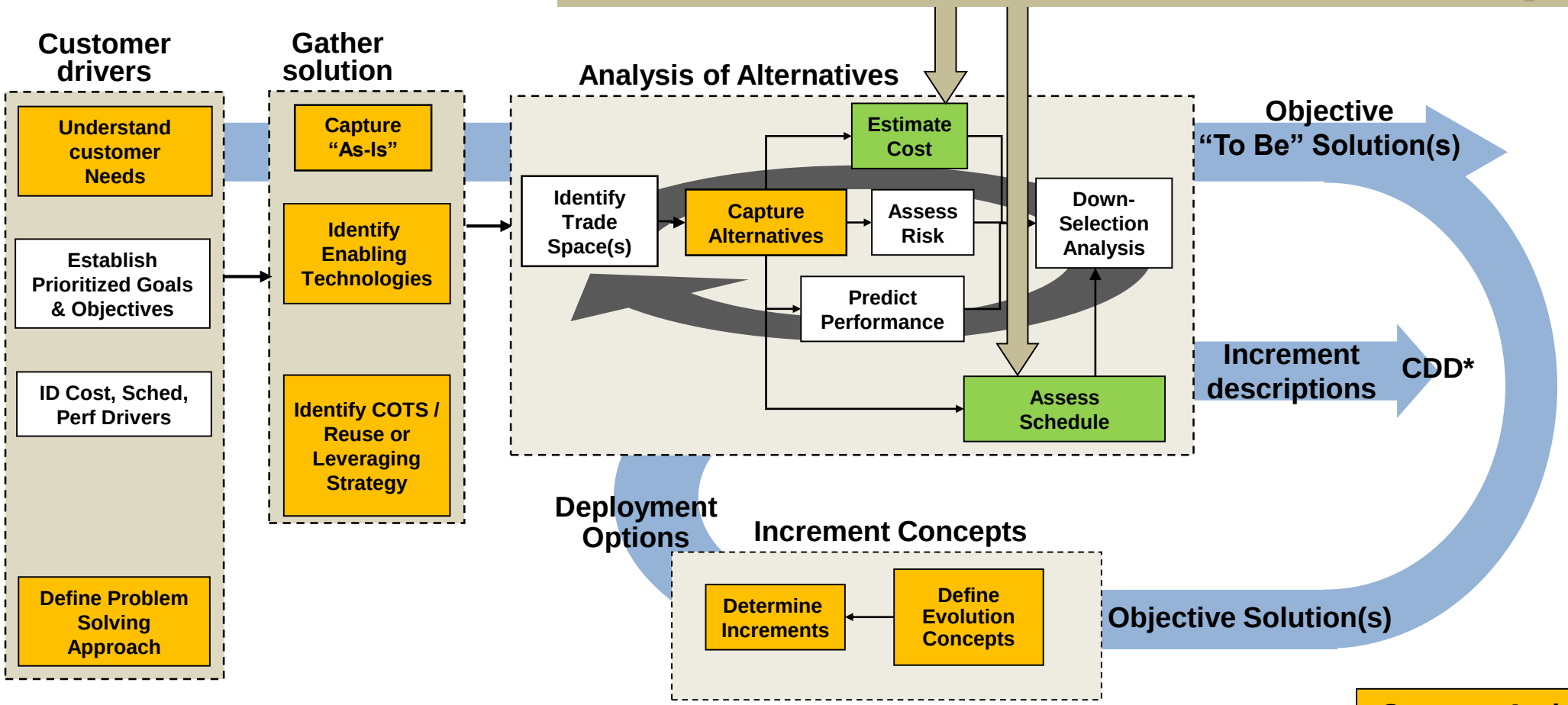
System Integration = Decompose into parts then integrate parts into whole – a realized system

System Integration: Analysis of Alternatives (AoA)

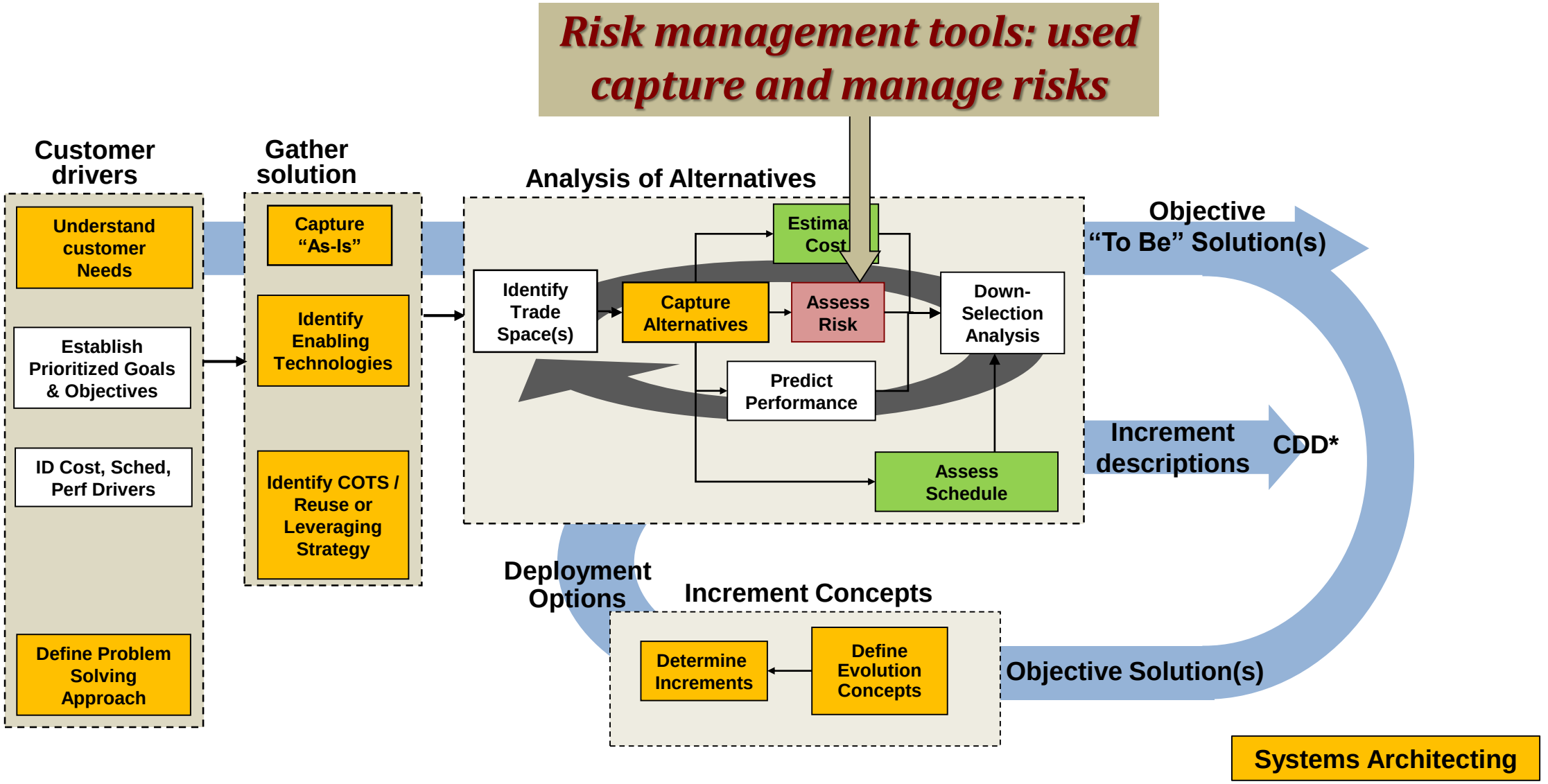


System Integration: Analysis of Alternatives (AoA)

- *Cost tools: perform cost analysis at various levels*
- *Schedule tools: used to assess schedule impacts*

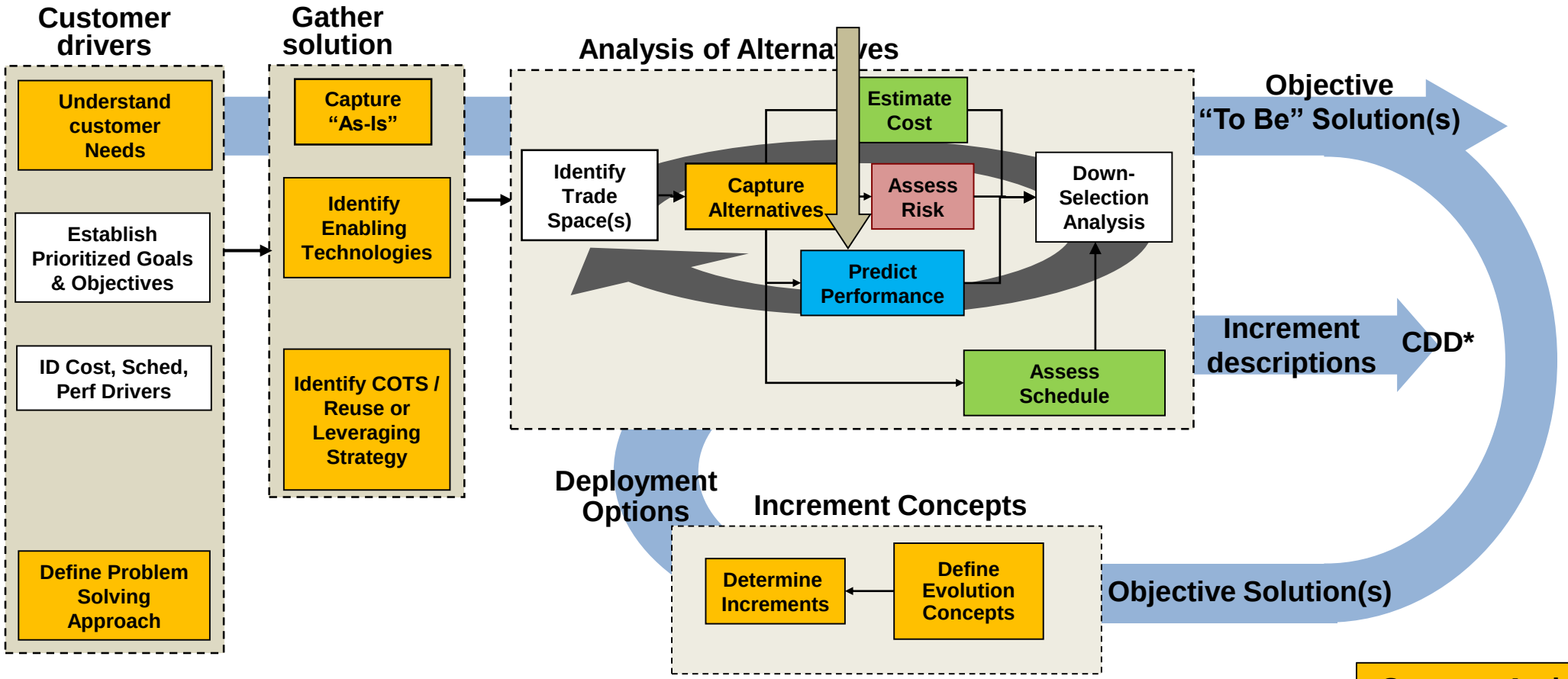


System Integration: Analysis of Alternatives (AoA)



System Integration: Analysis of Alternatives (AoA)

Modeling & Simulation: used for Performance/Effectiveness evaluation of Alternatives

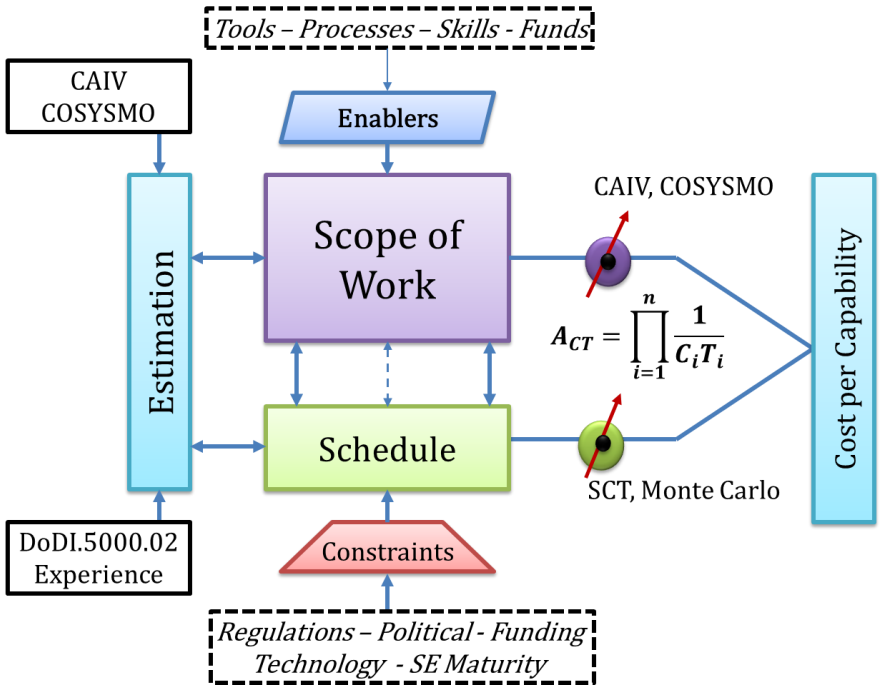


Cost & Schedule Integration

PROGRAM MANAGER:

- Responsible for achieving technical, cost, and schedule performance targets that satisfied the intended system objectives: *i.e. the intended system's performance met all operational parameters within cost and schedule targets.*

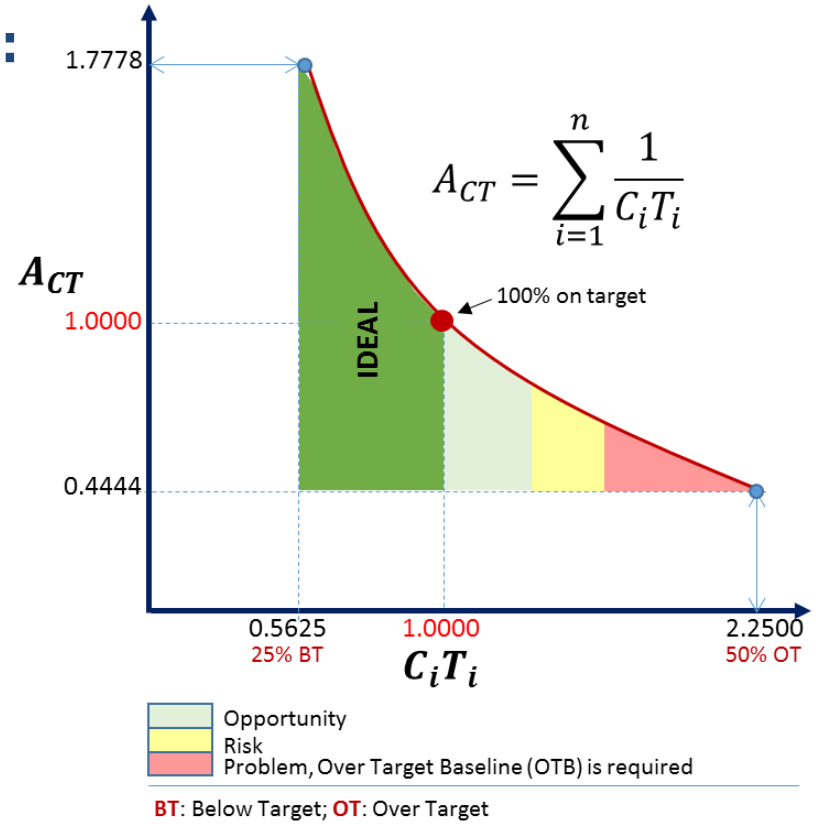
PLANNING:



EXECUTION:

Authorize Work

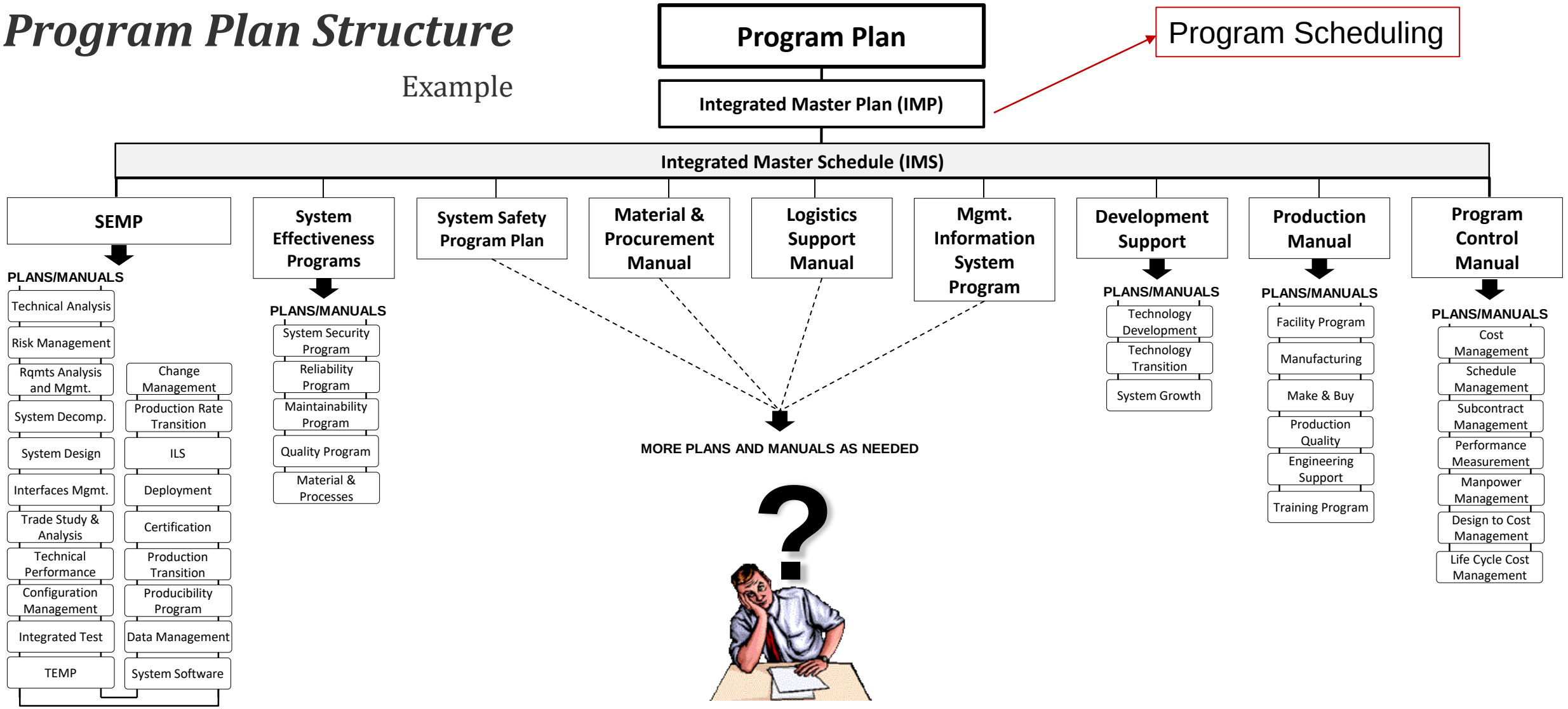
Measure to Baseline



PROGRAM INTEGRATION

Program Plan Structure

Example



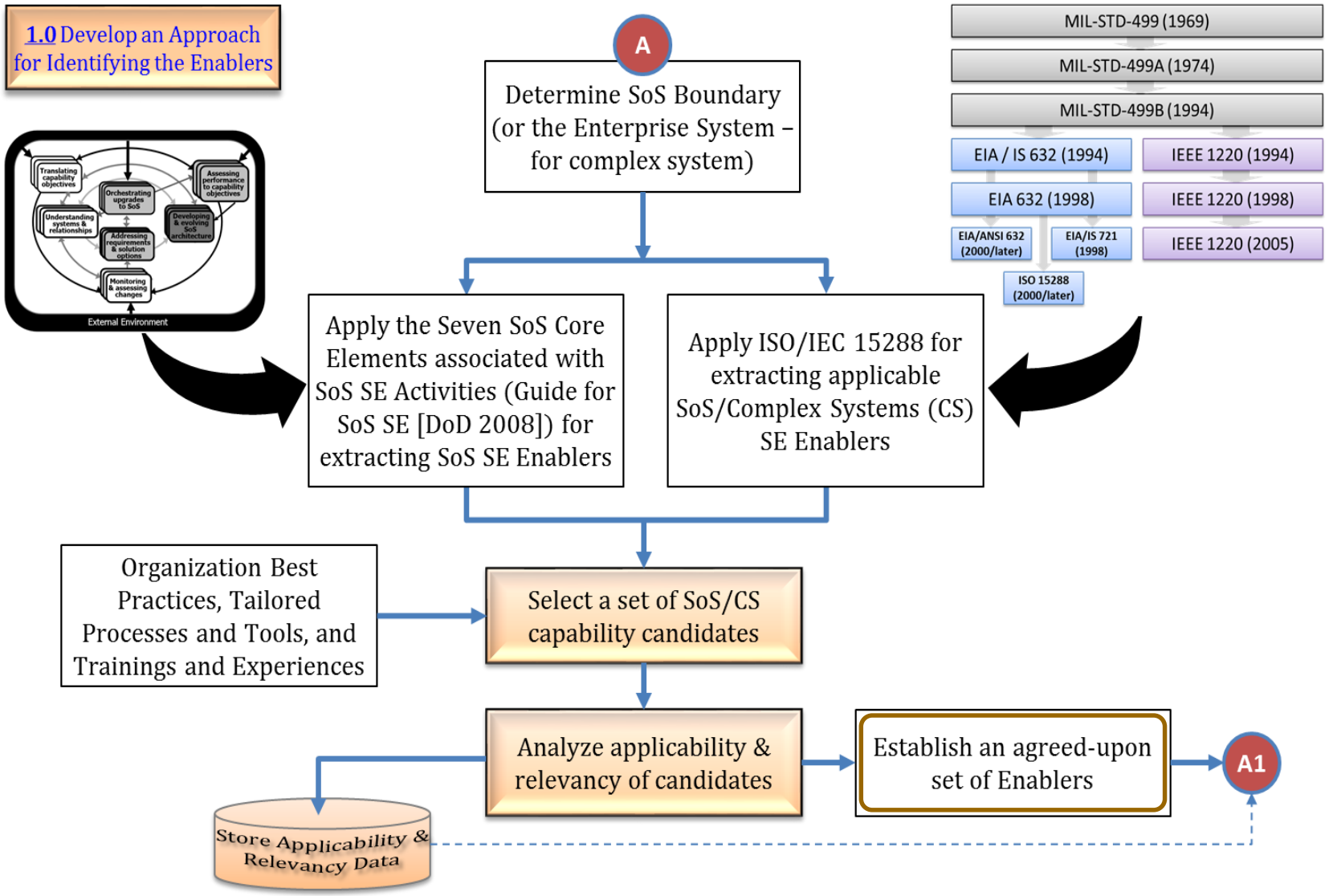
❑ AMAM - *Recap*

- ➢ OrgCap Model:
  - *Identify, Rank, and Assess Maturity Level of Enablers*
- ➢ TechPri Model:
  - *Assess Technical Performance Risk*
- ➢ CoSh Model:
  - *A Holistic View of Cost & Schedule Performance*

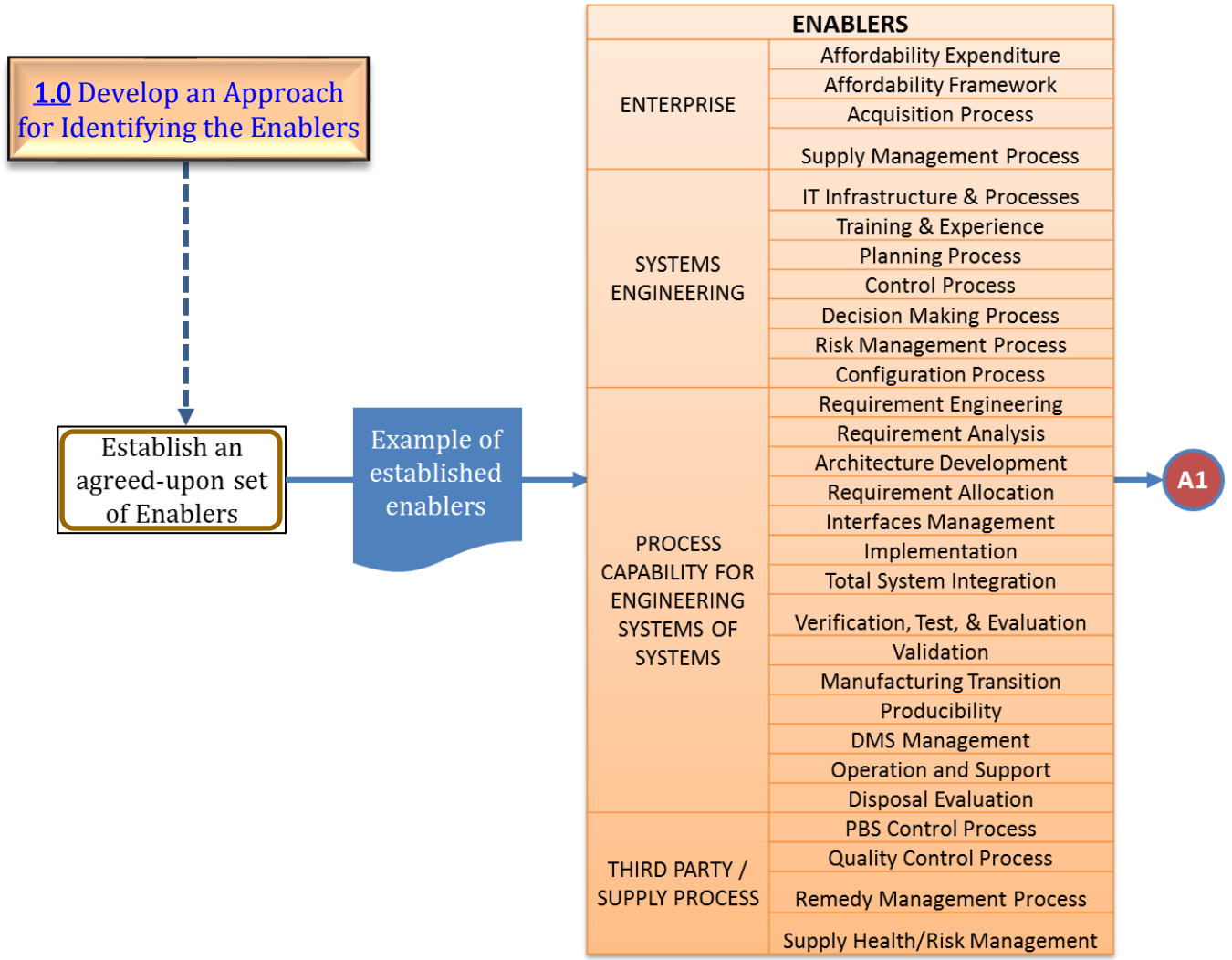
Organizational Capability Assessment

{OrgCap} Model

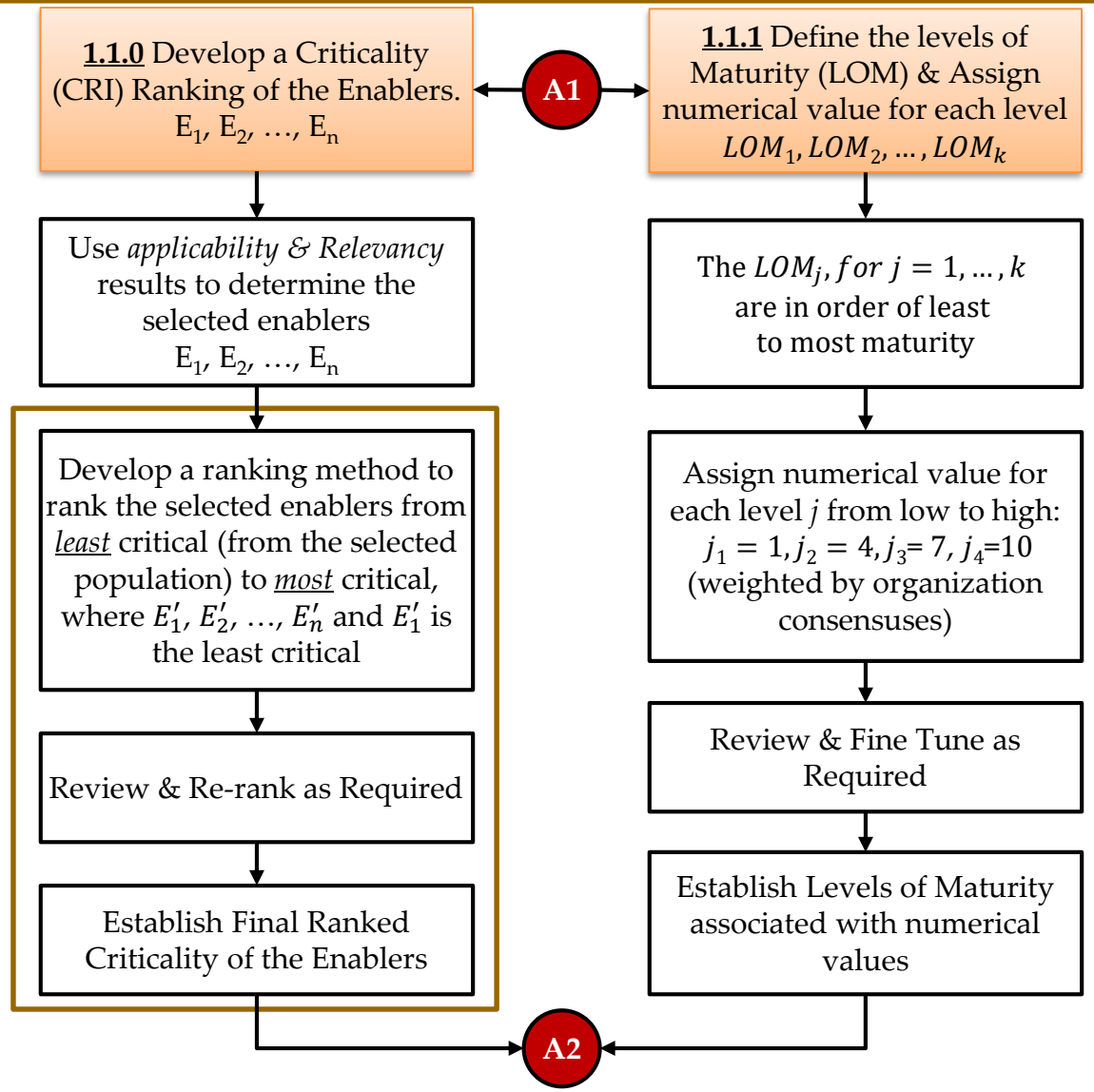
OrgCap Model



OrgCap Model



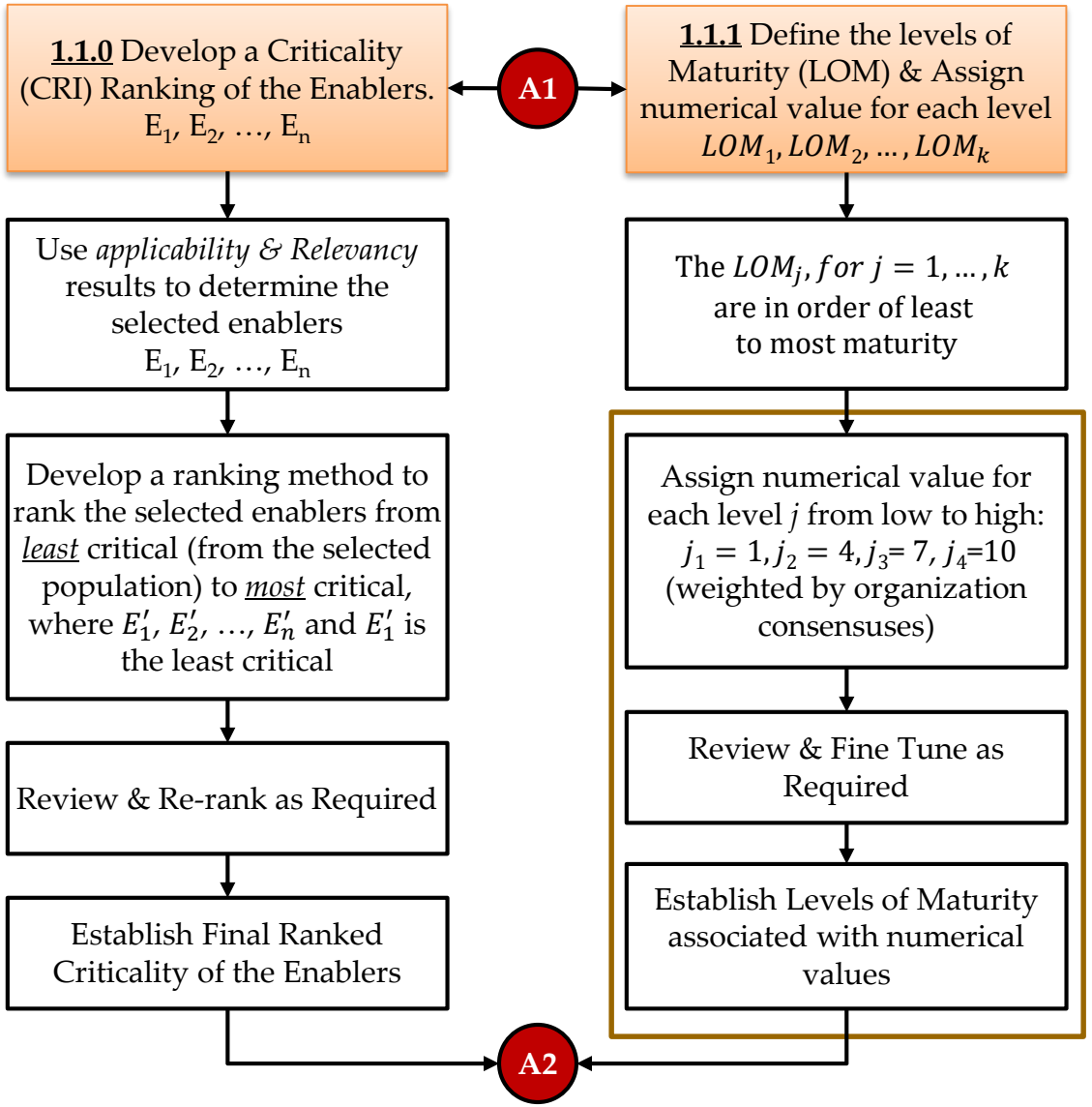
OrgCap Model



Criticality Level = Cost Relevant + Technology Enabler + Critical Path Item + Mandated item + Support item

ENABLERS		Is it Cost Relevant?	Is it Technology Enabler?	Is it Critical Path Item?	Is it Mandated Item?	Is It an On-Going Support Item?	Criticality Level
		(Yes [Y]=1; No [N]=0)					
ENTERPRISE	Affordability Expenditure	Y	Y	Y	Y	Y	5
	Affordability Framework	Y	N	Y	Y	Y	4
	Acquisition Process	N	N	N	Y	Y	2
	Supply Management Process	N	N	Y	Y	Y	3
SYSTEMS ENGINEERING & IT	IT Infrastructure & Processes	Y	Y	N	Y	Y	4
	Training & Experience	N	Y	N	Y	Y	3
	Planning Process	N	N	N	Y	Y	2
	Control Process	N	N	N	Y	Y	2
	Decision Making Process	Y	N	N	N	Y	2
	Risk Management Process	Y	N	N	Y	Y	3
	Configuration Process	Y	N	Y	Y	Y	4
PROCESS CAPABILITY FOR ENGINEERING SYSTEMS OF SYSTEMS	Requirement Engineering	Y	Y	Y	Y	Y	5
	Requirement Analysis	Y	Y	Y	Y	Y	5
	Architecture Development	Y	Y	Y	Y	Y	5
	Requirement Allocation	Y	Y	Y	Y	Y	5
	Interfaces Management	Y	N	Y	Y	Y	4
	Implementation	Y	Y	Y	Y	Y	5
	Total System Integration	Y	N	Y	Y	Y	4
	Verification, Test, & Evaluation	Y	N	Y	Y	Y	4
	Validation	Y	N	Y	Y	Y	4
	Manufacturing Transition	Y	Y	Y	Y	Y	5
	Producibility	Y	N	Y	Y	Y	4
	DMS Management	Y	N	Y	Y	N	3
	Operation and Support	Y	Y	Y	Y	Y	5
	Disposal Evaluation	Y	N	N	Y	N	2
THIRD PARTY / SUPPLY PROCESS	PBS Control Process	Y	N	Y	N	Y	3
	Quality Control Process	Y	N	Y	Y	Y	4
	Remedy Management Process	Y	N	N	N	Y	2
	Supply Health/Risk Management	Y	N	Y	N	Y	3

OrgCap Model



The $LOM_j, for\ j = 1, \ldots, k$ are in order of least to most maturity		Useful. Vaidated with MOE Results	Useful but not Measurable	to Support Specific Needs	Existed but Not Useful	Assessed LOM
		j_4	j_3	j_2	j_1	
ENABLERS		**10**	**7**	**4**	**1**	
ENTERPRISE	Affordability Expenditure	Y	N	N	N	10
	Affordability Framework	Y	N	N	N	10
	Acquisition Process	Y	N	N	N	10
	Supply Management Process	Y	N	N	N	10
SYSTEMS ENGINEERING & IT	IT Infrastructure & Processes	Y	N	N	N	10
	Training & Experience	Y	N	N	N	10
	Planning Process	Y	N	N	N	10
	Control Process	N	Y	N	N	7
	Decision Making Process	N	Y	N	N	7
	Risk Management Process	Y	N	N	N	10
	Configuration Process	Y	N	N	N	10
PROCESS CAPABILITY FOR ENGINEERING SYSTEMS OF SYSTEMS	Requirement Engineering	Y	N	N	N	10
	Requirement Analysis	Y	N	N	N	10
	Architecture Development	Y	N	N	N	10
	Requirement Allocation	Y	N	N	N	10
	Interfaces Management	Y	N	N	N	10
	Implementation	Y	N	N	N	10
	Total System Integration	Y	N	N	N	10
	Verification, Test, & Evaluation	Y	N	N	N	10
	Validation	Y	N	N	N	10
	Manufacturing Transition	N	Y	N	N	7
	Producibility	Y	N	N	N	10
	DMS Management	N	Y	N	N	7
	Operation and Support	N	Y	N	N	7
	Disposal Evaluation	N	N	Y	N	4
THIRD PARTY / SUPPLY	PBS Control Process	Y	N	N	N	10
	Quality Control Process	Y	N	N	N	10
	Remedy Management Process	N	Y	N	N	7

OrgCap Model

Establish Final Ranked Criticality of the Enablers

Establish Levels of Maturity associated with numerical values

A2

1.2.0 Develop an Organization Capability matrix, $A_{n\times k}$

Construct matrix, $A_{n\times k}$, where
ROW: $i = E'_1, E'_2, \ldots, E'_n$ *(Criticality of the selected Enablers)*
COLUMN: $j = LOM_1, LOM_2, \ldots, LOMk$ *(Level of Maturity)*

Assign CRI for each selected Enabler (Recommend to automate this process by automatically "pulling" the numerical values from the CRI Ranking)

Structure COLUMN j_1, j_2, j_3, and j_4 in according with the LOM assessment matrix (recommend to automate this process by automatically "pulling" the assessed results from the LOM assessment matrix)

Develop a Mathematical Model to Compute the Beta Value

A3

THE ORGCAP MODEL IS AUTOMATED - ALL Values ARE Automatically Calculated.

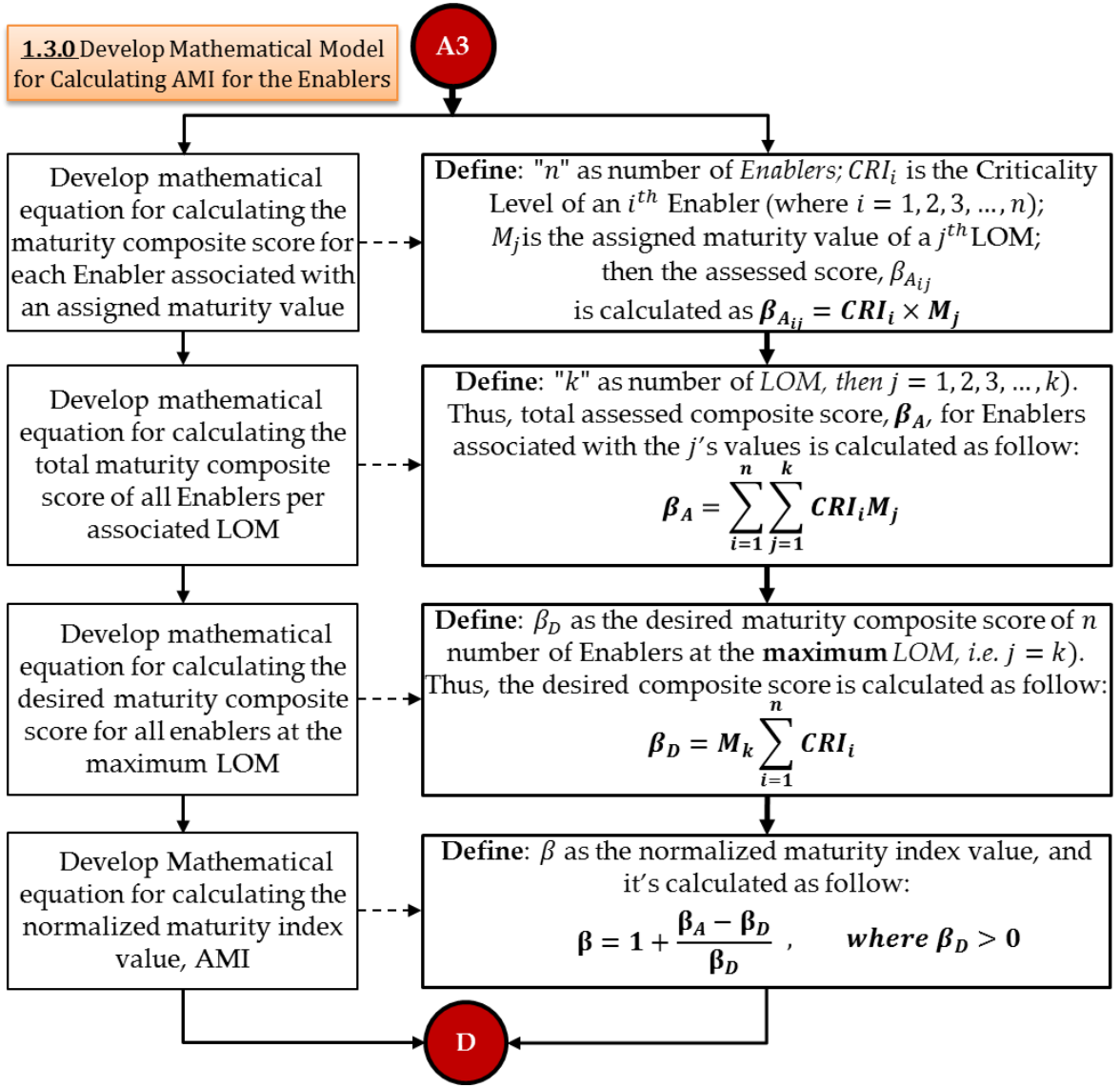
Calculated β: 0.969

Level of Maturity (LOM) = M_j where j_1 = Least Mature and J_4 = Mosst Mature

Level of Criticality = CRI_i, where i = 1, 2, 3,…, n (enablers)

ENABLERS		CRI_i	Very Useful. Vaidated with MOE Results j_4=10	Useful but not Measurable j_3=7	Tailorable to Support Specific Needs j_2=4	Existed but Not Useful j_1=1	Desired, β_D: 1060 / Assessed, β_A: 1027
ENTERPRISE	Affordability Expenditure	5	Y	N	N	N	50
	Affordability Framework	4	Y	N	N	N	40
	Acquisition Process	2	Y	N	N	N	20
	Supply Management Process	3	Y	N	N	N	30
	IT Infrastructure & Processes	4	Y	N	N	N	40
SYSTEMS ENGINEERING & IT	Planning Process	2	Y	N	N	N	20
	Control Process	2	N	Y	N	N	14
	Decision Making Process	2	N	Y	N	N	14
	Risk Management Process	3	Y	N	N	N	30
	Configuration Process	4	Y	N	N	N	40
PROCESS CAPABILITY FOR ENGINEERING SYSTEMS OF SYSTEMS	Requirement Engineering	5	Y	N	N	N	50
	Requirement Analysis	5	Y	N	N	N	50
	Architecture Development	5	Y	N	N	N	50
	Requirement Allocation	5	Y	N	N	N	50
	Interfaces Management	4	Y	N	N	N	40
	Implementation	5	Y	N	N	N	50
	Total System Integration	4	Y	N	N	N	40
	Verification, Test, & Evaluation	4	Y	N	N	N	40
	Validation	4	Y	N	N	N	40
	Manufacturing Transition	5	N	Y	N	N	35
	Producibility	4	Y	N	N	N	40
	DMS Management	3	N	Y	N	N	21
	Operation and Support	5	N	Y	N	N	35
	Disposal Evaluation	2	N	N	Y	N	8
THIRD PARTY / SUPPLY PROCESS	PBS Control Process	3	Y	N	N	N	30
	Quality Control Process	4	Y	N	N	N	40
	Remedy Management Process	2	N	Y	N	N	14
	Supply Health/Risk Management	3	Y	N	Y	Y	45

OrgCap Model



	M_j	j_4	j_3	j_2	j_1	Desired β	
	CRI_i	*Hi=*	*Mo=*	*Lo=*	*Mi=*	*Min*	*Max*
		10	***7***	***4***	***1***	***1***	***10***
Tools	***2***	*0*	*14*	*0*	*0*	2	20
Process	***1***	*10*	*0*	*0*	*0*	1	10
Experience	***4***	*0*	*28*	*0*	*0*	4	40
Funding	***5***	*50*	*0*	*0*	*0*	5	50
Technology	***3***	*30*	*0*	*0*	*0*	3	30
		90	*42*	*0*	***0***	**15**	**150**
		Assessed β_A = 132				*Pick:*	*150*

$$\boldsymbol{\beta_A = \sum_{i=1}^{n}\sum_{j=1}^{k} CRI_i M_j = CRI_1M_1 + CRI_1M_2 + \ldots + CRI_2M_1 + CRI_2M_2 + \ldots}$$

$$\boldsymbol{\beta_A = \sum_{i=1}^{5}\sum_{j=1}^{4} CRI_i M_j = CRI_1M_3 + CRI_2M_3 + CRI_3M_3 + CRI_4M_4 + CRI_5M_4}$$

$$\boldsymbol{= (2)(7) + (1)(10) + (4)(7) + (5)(10) + (3)(10) = 132}$$

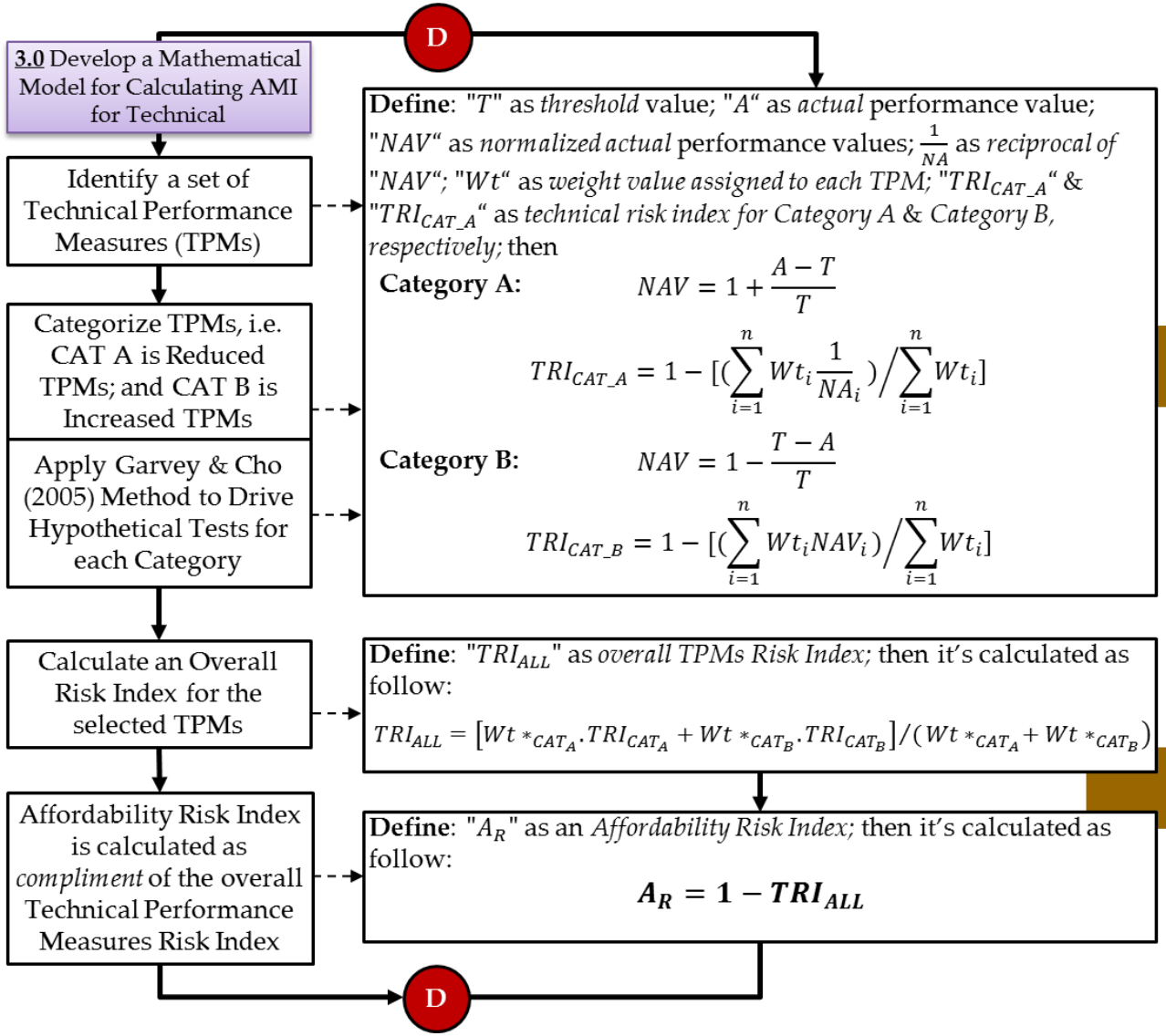
$$\boldsymbol{\beta_D = M_{(k=j_4)} \sum_{i=1}^{n} CRI_i = (10)(2 + 1 + 4 + 5 + 3) = 150}$$

$$\boldsymbol{\beta = 1 + \frac{132 - 150}{150} = 0.880}$$

Technical Performance Risk Index

{TecPri} Model

TecPri Model: TPMs Performance Risk



Define: "T" as *threshold* value; "A" as *actual* performance value; "NAV" as *normalized actual* performance values; $\frac{1}{NA}$ as *reciprocal of* "NAV"; "Wt" as *weight value assigned to each TPM;* "TRI_{CAT_A}" & "TRI_{CAT_A}" as *technical risk index for Category A & Category B, respectively;* then

Category A:

$$NAV = 1 + \frac{A - T}{T}$$

$$TRI_{CAT\_A} = 1 - [(\sum_{i=1}^{n} Wt_i \frac{1}{NA_i}) / \sum_{i=1}^{n} Wt_i]$$

Category B:

$$NAV = 1 - \frac{T - A}{T}$$

$$TRI_{CAT\_B} = 1 - [(\sum_{i=1}^{n} Wt_i NAV_i) / \sum_{i=1}^{n} Wt_i]$$

Define: "TRI_{ALL}" as *overall TPMs Risk Index;* then it's calculated as follow:

$$TRI_{ALL} = [Wt*_{CAT_A}.TRI_{CAT_A} + Wt*_{CAT_B}.TRI_{CAT_B}]/(Wt*_{CAT_A} + Wt*_{CAT_B})$$

Define: "A_R" as an *Affordability Risk Index;* then it's calculated as follow:

$$A_R = 1 - TRI_{ALL}$$

CAT_A TPMs	Threshold	Actual	Wt.	NAV	1/NAV
w (lbs.)	2.2	4	2	1.8182	0.5500
Noise Level (dB)	6	7	1	1.1667	0.8571
MTMR (hrs)	1.25	2	1	1.6000	0.6250
TRi_A					0.35446
CAT_B TPMs	Threshold	Actual	Wt.	NAV	1/NAV
range (mile)	3	2.75	1	0.9167	1.0909
clarity (level)	2	1.5	1	0.7500	1.3333
fh (hrs)	2	1.5	1	0.7500	1.3333
TRi_B					0.19444
TRi_{ALL}					0.28588
A_R			$=1-TRi_{ALL}$		0.71412

Cost and Schedule Performance Assessment

CoSh Model

CoSh Model

2.0 Develop an Approach for assessment of Cost & Schedule Performance Risk Index

B

Develop mathematical equation for assessing cost performance of a recent program/project on n number of defined capabilities

Define: "n" as number of capabilities being assessed; C_i is the Cost performance index of an i^{th} capability (where $i = 1 \dots n$); C_{actual^i} is the actual $ spent on developing i^{th} capability and $C_{baseline^i}$ is budgeted $ for the same capability; then

$$C_i = \frac{C_{actual^i}}{C_{baseline^i}} = \begin{cases} < 1, underrun \\ = 1, on\ target \\ > 1, overrun \end{cases}$$

Develop mathematical equation for assessing schedule performance of a recent program/project on n number of defined capabilities

Define: "n" as number of capabilities being assessed; T_i is Schedule performance index of an i^{th} capability (where $i = 1 \dots n$); T_{actual^i} is the *time* spent on developing i^{th} capability and $T_{baseline^i}$ is allowed *time* for developing the i^{th} capability; then

$$T_i = \frac{T_{actual^i}}{T_{baseline^i}} = \begin{cases} < 1, ahead \\ = 1, on\ track \\ > 1, behind \end{cases}$$

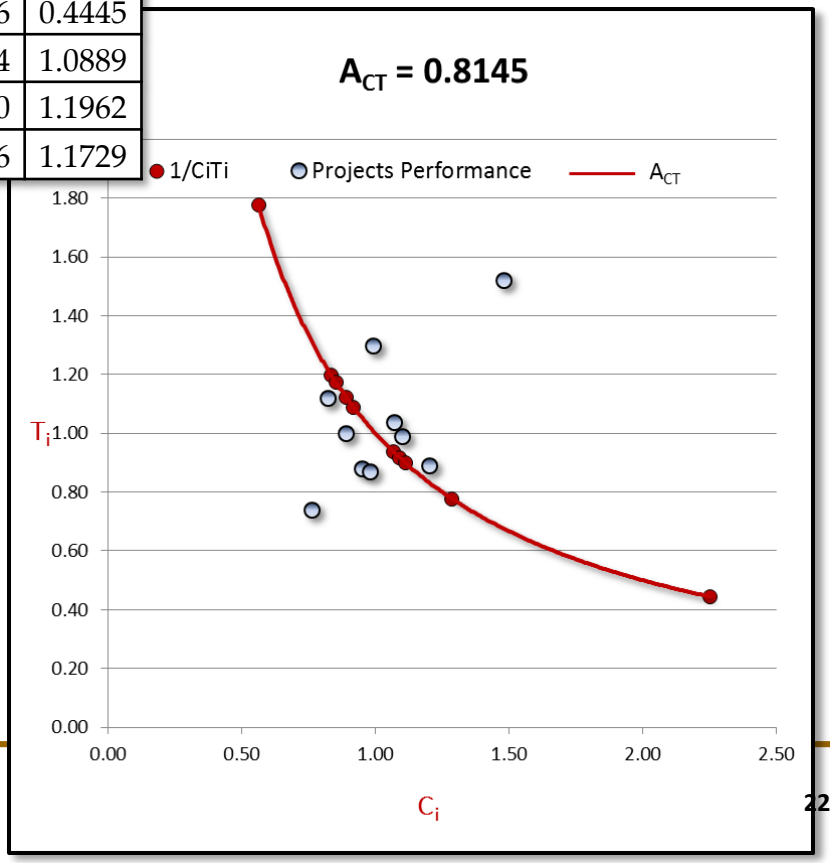
B1 Develop a Mathematical Model for Calculating AMI for Cost & Technical Performance

Define: A_{CT} as *affordability risk index* of based upon *cost* and *schedule* performance indices, then A_{CT} is calculated as follow:

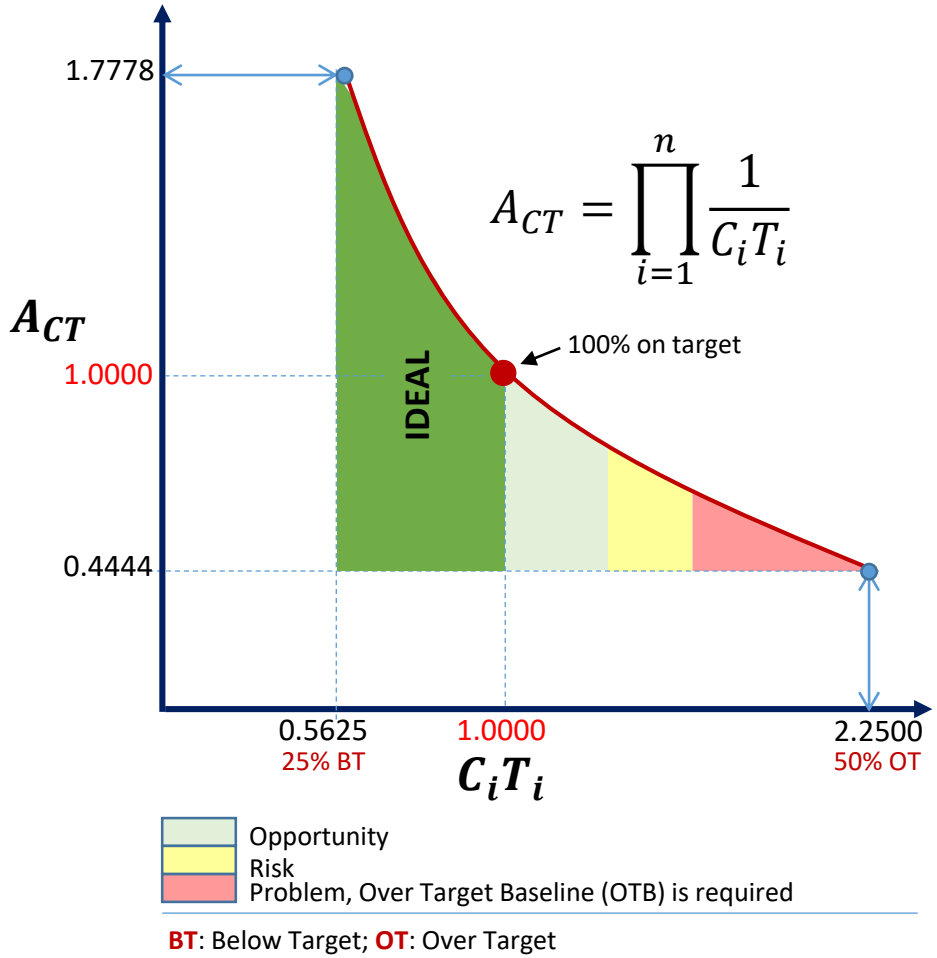
$$A_{CT} = \prod_{i=1}^{n} \frac{1}{C_i T_i}, \text{for } C_i > 0 \text{ and } T_i > 0$$

D

	A_{CT} =		0.8145	
Project	C_i	T_i	C_iT_i	$1/C_iT_i$
1	0.99	1.30	1.2870	0.7770
2	0.76	0.74	0.5624	1.7781
3	1.20	0.89	1.0680	0.9363
4	1.10	0.99	1.0890	0.9183
5	1.07	1.04	1.1128	0.8986
6	0.89	1.00	0.8900	1.1236
7	1.48	1.52	2.2496	0.4445
8	0.82	1.12	0.9184	1.0889
9	0.95	0.88	0.8360	1.1962
10	0.98	0.87	0.8526	1.1729



CoSh Model



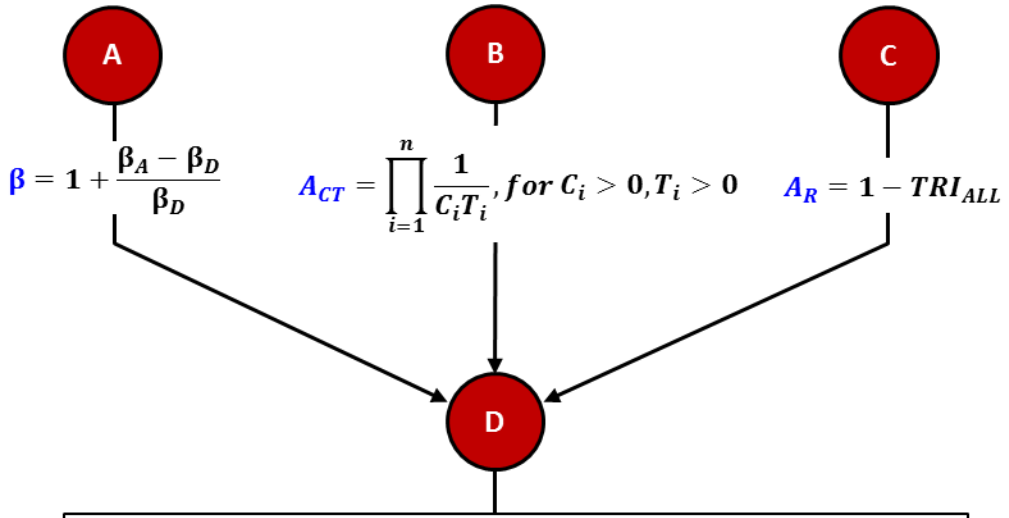
Affordability Maturity Index

AMI Model

Methodology Development Approach : AMI Model

4.0 Develop an AMI Mathematical model that integrates Enablers, Program Management, TRI Maturity Indices

OrgCap Model | **CoSh Model** | **TecPri Model**

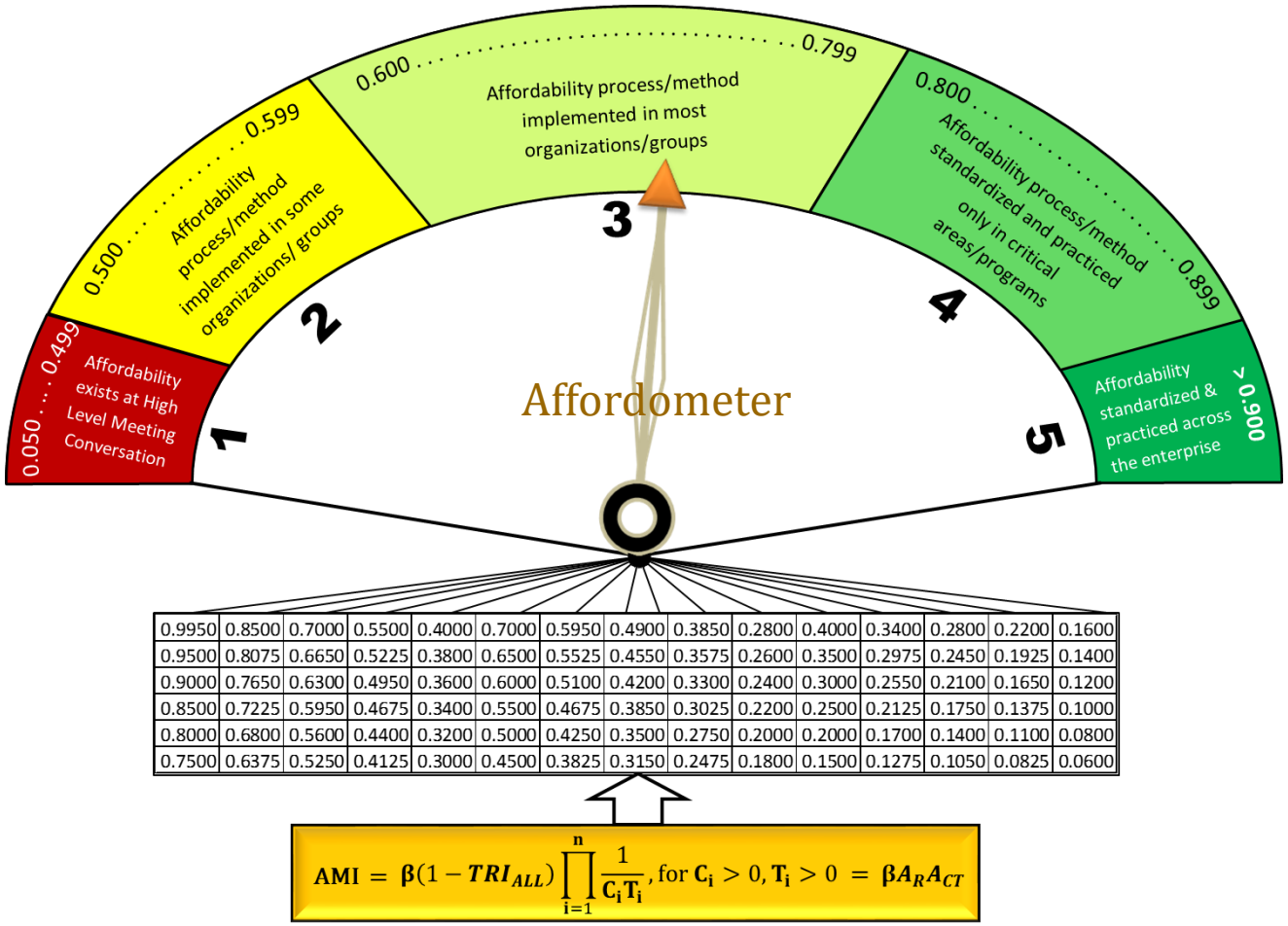


$$AMI = \beta(1 - TRI_{ALL}) \prod_{i=1}^{n} \frac{1}{C_i T_i}, \text{for } C_i > 0, T_i > 0 \quad \text{(Eq. 9)}$$

CoSh	TecPri	OrgCap
0.05	0.05	0.05
0.10	0.10	0.10
0.15	0.15	0.15
0.20	0.20	0.20
0.25	0.25	0.25
0.30	0.30	0.30
0.35	0.35	0.35
0.40	0.40	0.40
0.45	0.45	0.45
0.50	0.50	0.50
0.55	0.55	0.55
0.60	0.60	0.60
0.65	0.65	0.65
0.70	0.70	0.70
0.75	0.75	0.75
0.80	0.80	0.80
0.85	0.85	0.85
0.90	0.90	0.90
0.95	0.95	0.95
1.00	1.00	1.00

Affordometer: LEVEL 1; LEVEL 2; LEVEL 3; LEVEL 4; LEVEL 5														
1.000	0.767	0.713	0.650	0.618	0.595	0.565	0.540	0.523	0.504	0.488	0.470	0.456	0.446	0.432
0.950	0.765	0.700	0.650	0.618	0.595	0.565	0.540	0.523	0.504	0.486	0.470	0.456	0.444	0.432
0.950	0.765	0.700	0.650	0.614	0.587	0.565	0.540	0.523	0.500	0.486	0.470	0.455	0.444	0.432
0.950	0.765	0.700	0.648	0.612	0.587	0.565	0.540	0.523	0.500	0.486	0.470	0.455	0.444	0.428
0.903	0.765	0.689	0.648	0.612	0.587	0.563	0.540	0.523	0.500	0.485	0.470	0.455	0.444	0.428
0.903	0.765	0.689	0.648	0.612	0.585	0.563	0.540	0.520	0.499	0.485	0.470	0.455	0.444	0.428
0.903	0.765	0.689	0.646	0.612	0.585	0.563	0.540	0.520	0.499	0.485	0.470	0.455	0.444	0.428
0.900	0.760	0.686	0.646	0.612	0.585	0.560	0.540	0.520	0.499	0.485	0.470	0.455	0.442	0.428
0.900	0.760	0.686	0.646	0.612	0.585	0.560	0.540	0.520	0.499	0.485	0.470	0.451	0.442	0.428
0.900	0.760	0.686	0.646	0.608	0.585	0.560	0.536	0.520	0.499	0.485	0.468	0.451	0.442	0.428
0.857	0.760	0.684	0.646	0.608	0.585	0.560	0.536	0.520	0.499	0.480	0.468	0.451	0.442	0.428
0.855	0.760	0.684	0.646	0.608	0.578	0.560	0.536	0.513	0.497	0.480	0.468	0.450	0.442	0.428
0.855	0.760	0.684	0.641	0.608	0.578	0.560	0.536	0.513	0.497	0.480	0.468	0.450	0.442	0.428
0.855	0.750	0.684	0.641	0.608	0.578	0.556	0.536	0.513	0.497	0.480	0.468	0.450	0.441	0.428
0.855	0.750	0.684	0.641	0.608	0.576	0.556	0.536	0.513	0.497	0.480	0.468	0.450	0.441	0.428
0.855	0.750	0.684	0.641	0.606	0.576	0.556	0.534	0.513	0.497	0.480	0.468	0.450	0.441	0.428
0.855	0.729	0.680	0.641	0.606	0.576	0.556	0.534	0.513	0.497	0.480	0.468	0.450	0.440	0.428
0.850	0.727	0.680	0.641	0.606	0.574	0.556	0.534	0.512	0.496	0.480	0.468	0.450	0.440	0.428
0.850	0.727	0.680	0.640	0.606	0.574	0.556	0.532	0.510	0.496	0.480	0.468	0.450	0.440	0.428
0.850	0.727	0.680	0.640	0.606	0.574	0.553	0.532	0.510	0.496	0.478	0.468	0.450	0.440	0.428
0.812	0.727	0.680	0.640	0.606	0.574	0.553	0.532	0.510	0.495	0.478	0.468	0.450	0.440	0.428
0.812	0.727	0.680	0.638	0.600	0.574	0.553	0.532	0.510	0.495	0.478	0.466	0.450	0.440	0.425
0.812	0.727	0.677	0.638	0.600	0.574	0.553	0.532	0.510	0.495	0.476	0.466	0.450	0.439	0.425
0.810	0.723	0.677	0.638	0.600	0.570	0.553	0.532	0.510	0.495	0.476	0.466	0.450	0.439	0.425
0.810	0.723	0.677	0.638	0.600	0.570	0.553	0.527	0.510	0.495	0.476	0.463	0.450	0.439	0.425
0.810	0.723	0.675	0.638	0.600	0.570	0.550	0.527	0.510	0.495	0.476	0.463	0.450	0.439	0.425
0.808	0.722	0.675	0.638	0.600	0.570	0.550	0.527	0.510	0.494	0.476	0.463	0.450	0.439	0.425
0.808	0.722	0.675	0.632	0.600	0.570	0.550	0.525	0.510	0.494	0.476	0.463	0.450	0.439	0.423

AMI Model



0.9950	0.8500	0.7000	0.5500	0.4000	0.7000	0.5950	0.4900	0.3850	0.2800	0.4000	0.3400	0.2800	0.2200	0.1600
0.9500	0.8075	0.6650	0.5225	0.3800	0.6500	0.5525	0.4550	0.3575	0.2600	0.3500	0.2975	0.2450	0.1925	0.1400
0.9000	0.7650	0.6300	0.4950	0.3600	0.6000	0.5100	0.4200	0.3300	0.2400	0.3000	0.2550	0.2100	0.1650	0.1200
0.8500	0.7225	0.5950	0.4675	0.3400	0.5500	0.4675	0.3850	0.3025	0.2200	0.2500	0.2125	0.1750	0.1375	0.1000
0.8000	0.6800	0.5600	0.4400	0.3200	0.5000	0.4250	0.3500	0.2750	0.2000	0.2000	0.1700	0.1400	0.1100	0.0800
0.7500	0.6375	0.5250	0.4125	0.3000	0.4500	0.3825	0.3150	0.2475	0.1800	0.1500	0.1275	0.1050	0.0825	0.0600

$$\mathbf{AMI} = \beta(1 - TRI_{ALL}) \prod_{i=1}^{n} \frac{1}{C_i T_i}, \text{for } C_i > 0, T_i > 0 = \beta A_R A_{CT}$$

Affordability Maturity Levels

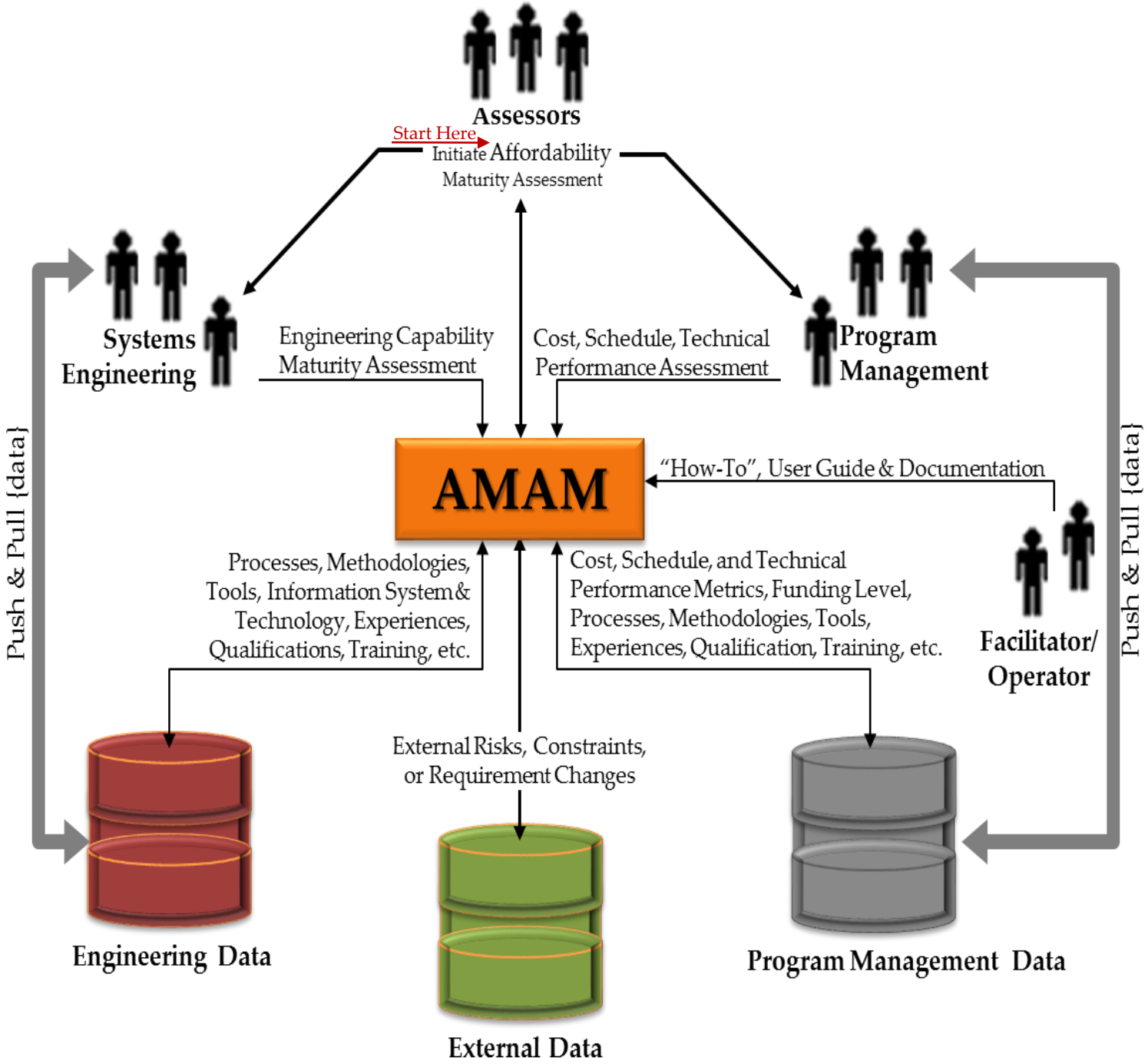
Level	CODE	Maturity Assessment Description
1	A1	Program is at significant risk. Total Program Review is needed
2	A2	Re-planning Restructuring Redefining Scope of work
3	A3	Program is on track with moderate risks
4	A4	Program is on track with minimal risks
5	A5	Program is on track in all categories

Implementation of the AMAM

How to Apply These Models to Existing Development Programs

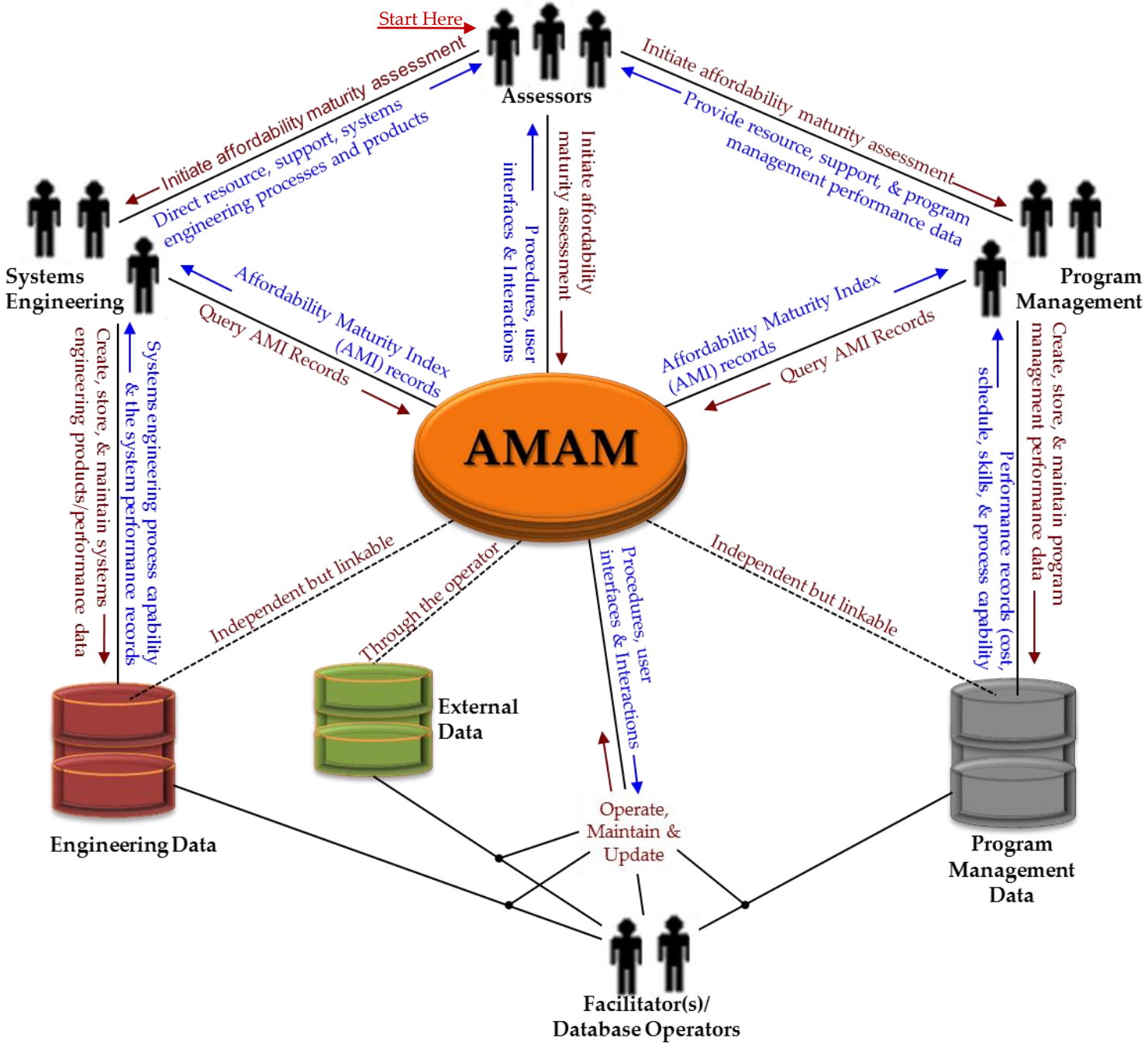
: The Processes

The AMAM Activities Model



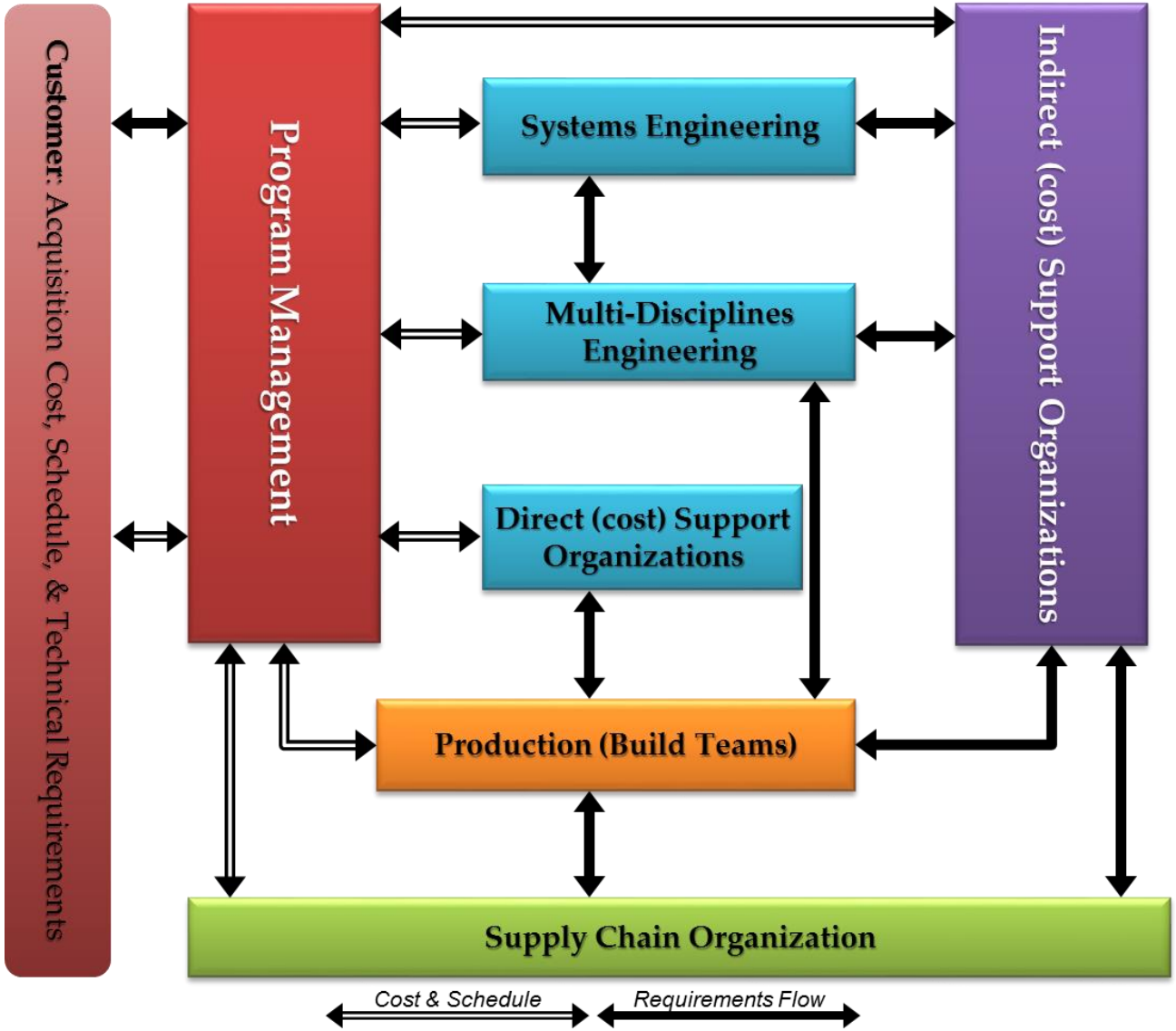
: The Processes

The AMAM Operational Roles



: The Processes

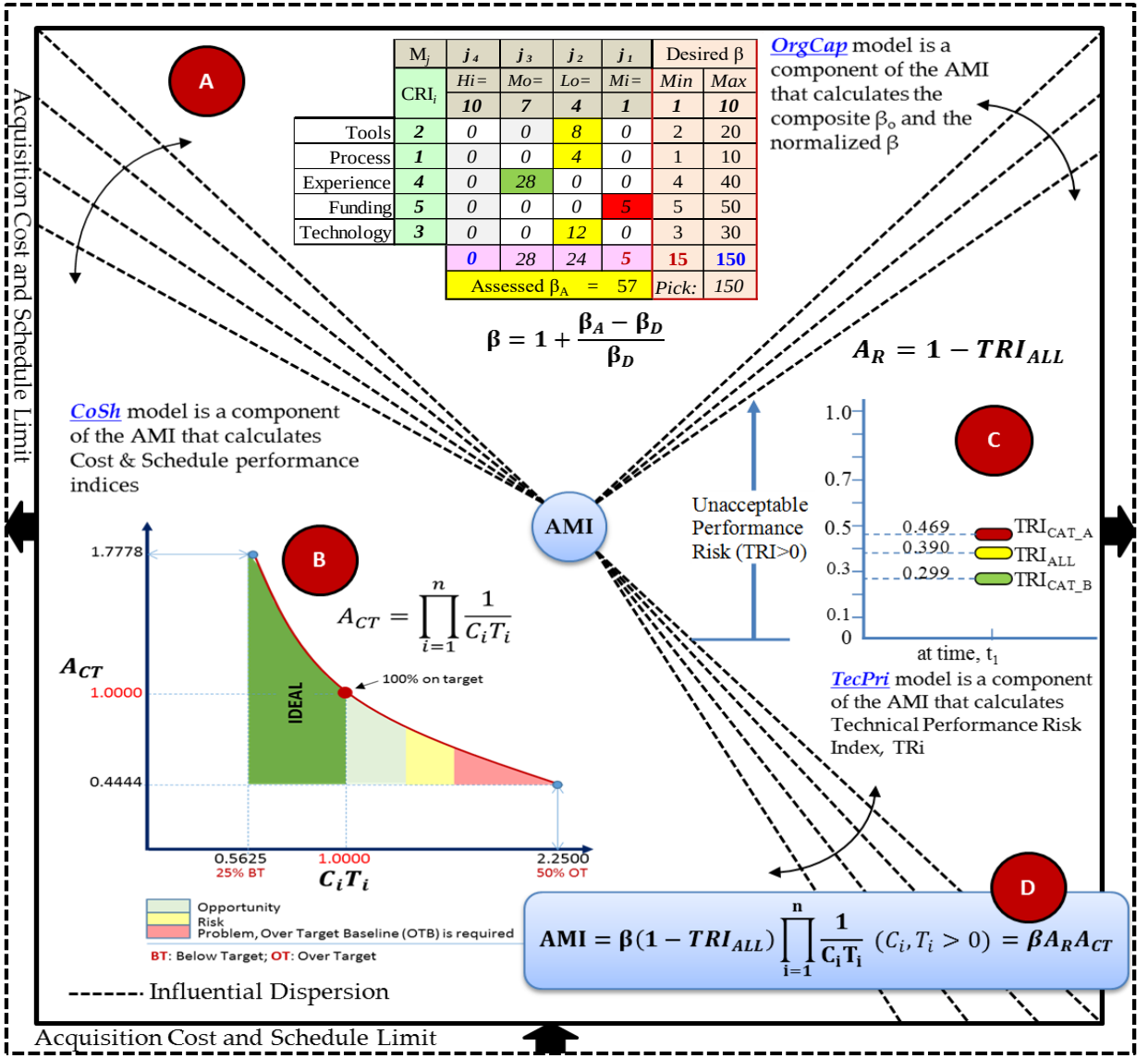
The AMAM Notional Organizational Relationship



: The Processes

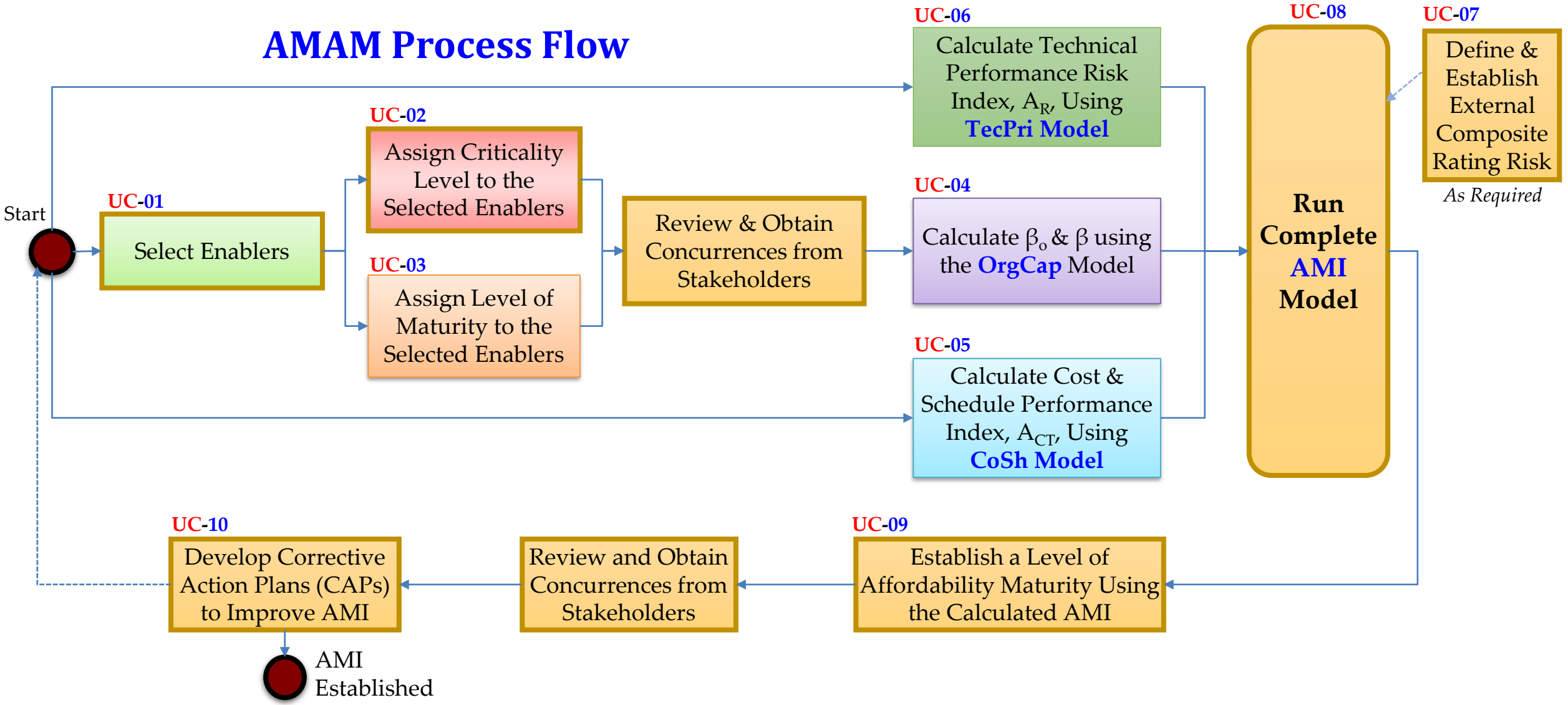
Dispersion of Cost, Schedule, Technical Performance Risk on Affordability

AMI= (OrgCap)(TecPri)(CoSh)



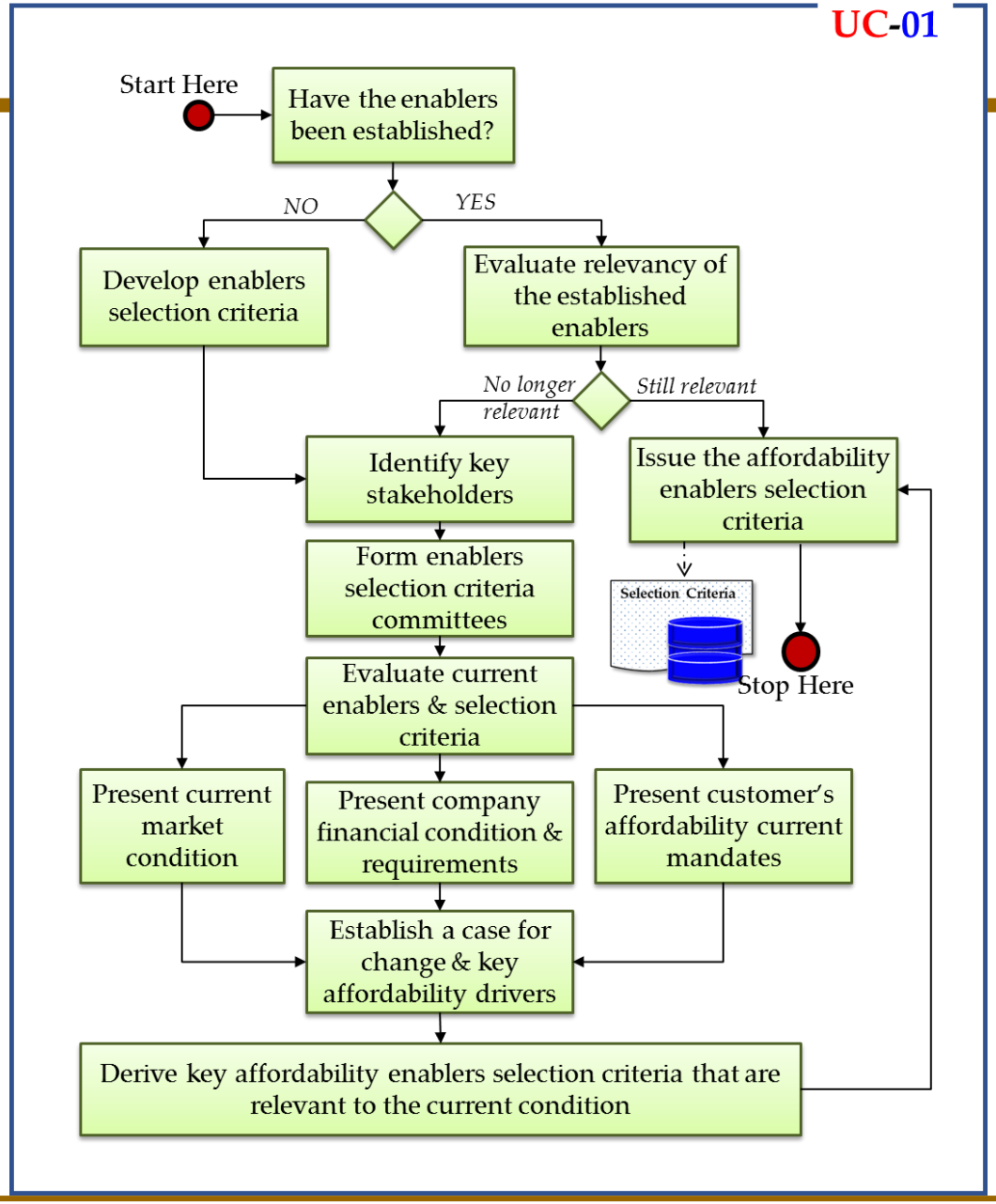
	CRI_i	j_4 Hi= 10	j_3 Mo= 7	j_2 Lo= 4	j_1 Mi= 1	Desired β Min 1	Max 10
Tools	2	0	0	8	0	2	20
Process	1	0	0	4	0	1	10
Experience	4	0	28	0	0	4	40
Funding	5	0	0	0	5	5	50
Technology	3	0	0	12	0	3	30
		0	28	24	5	15	150

Methodology Development Approach : The Processes



: The Processes

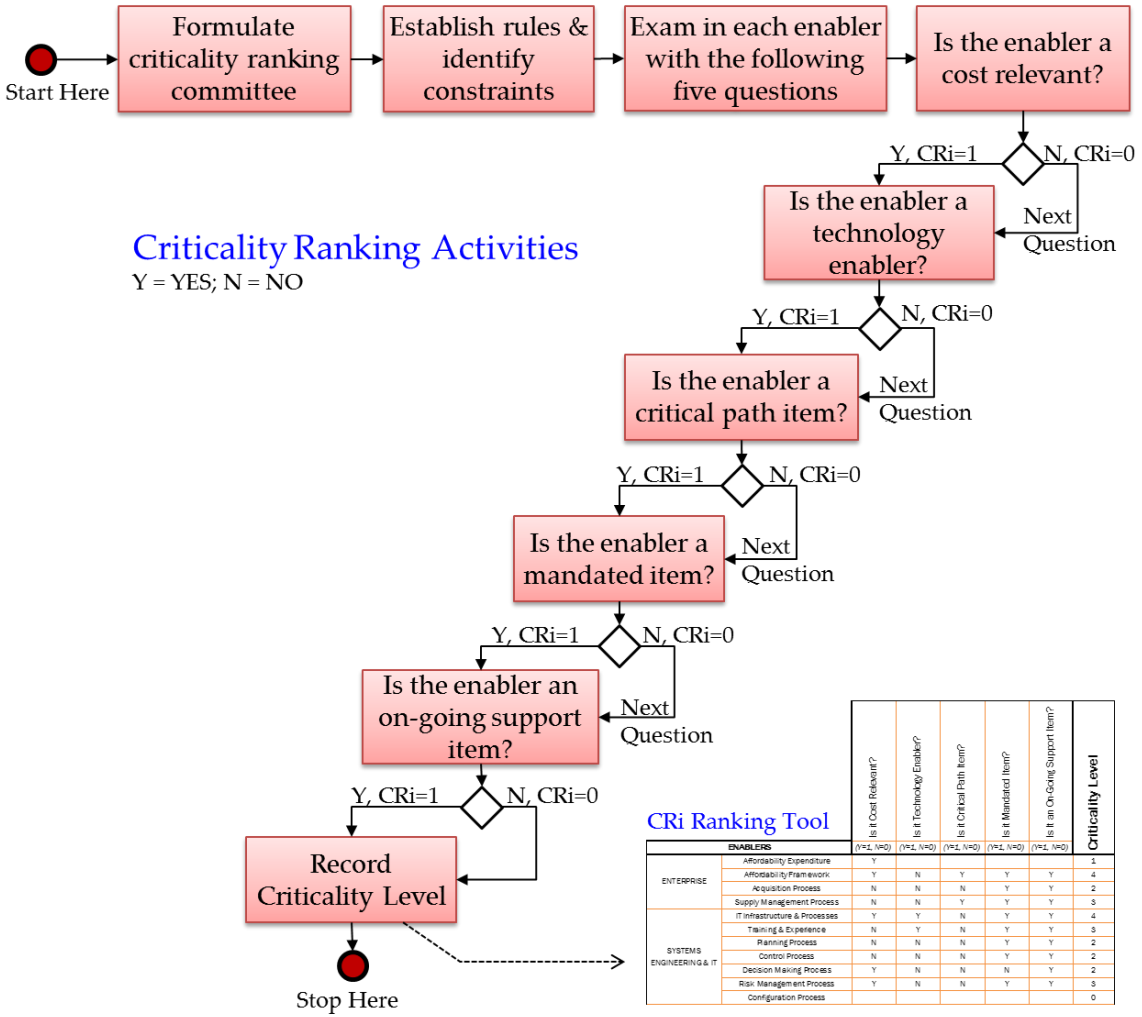
Select Enablers



: The Processes

Criticality Assignment and Ranking

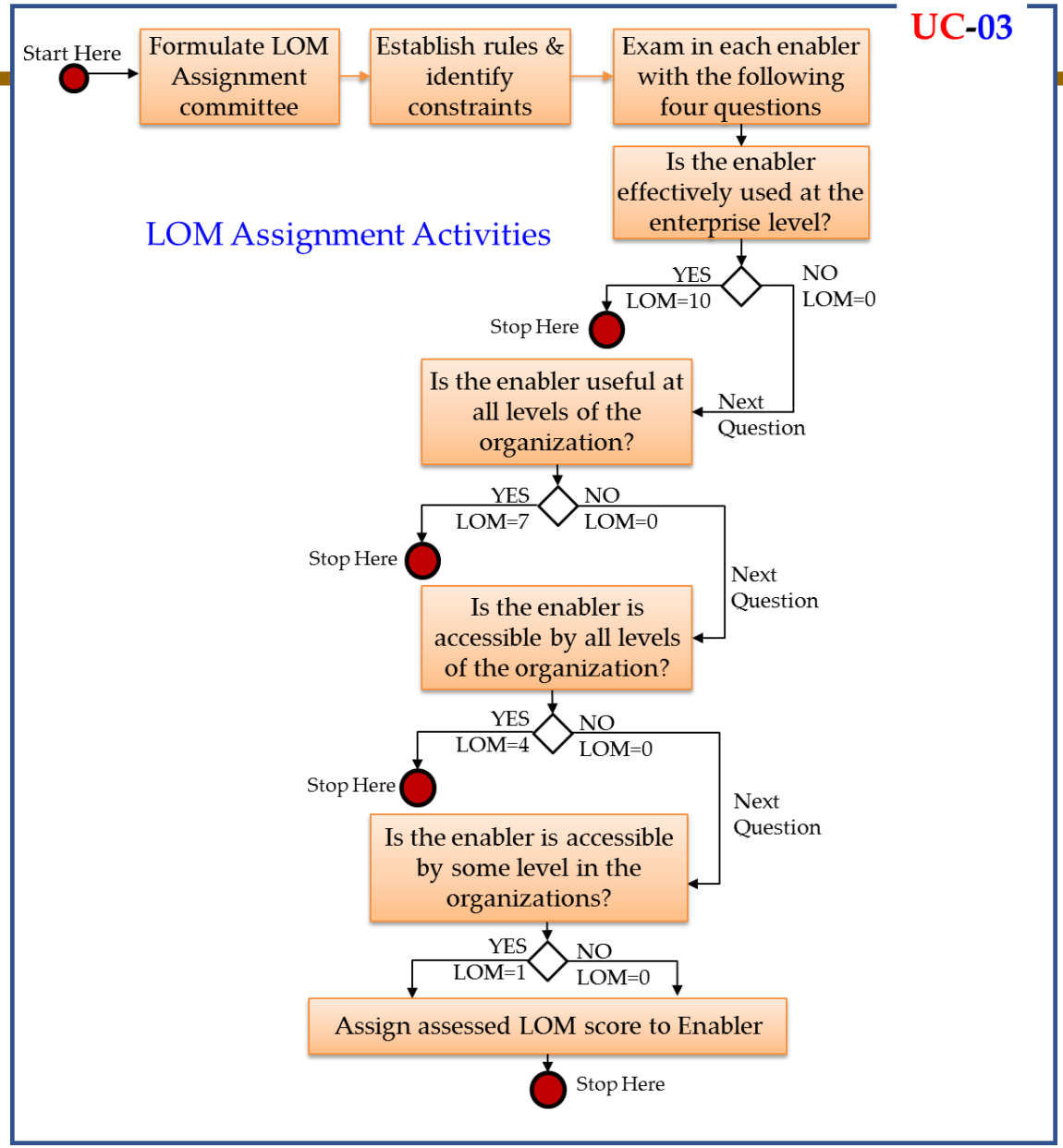
UC-02



ENABLERS		Is it Cost Relevant? (Y=1, N=0)	Is it Technology Enabler? (Y=1, N=0)	Is it Critical Path Item? (Y=1, N=0)	Is it Mandated Item? (Y=1, N=0)	Is it an On-Going Support Item? (Y=1, N=0)	Criticality Level
ENTERPRISE	Affordability Expenditure	Y					1
	Affordability Framework	Y	N	Y	Y	Y	4
	Acquisition Process	N	N	N	Y	Y	2
	Supply Management Process	N	N	Y	Y	Y	3
SYSTEMS ENGINEERING & IT	IT Infrastructure & Processes	Y	Y	N	Y	Y	4
	Training & Experience	N	Y	N	Y	Y	3
	Planning Process	N	N	N	Y	Y	2
	Control Process	N	N	N	Y	Y	2
	Decision Making Process	Y	N	N	N	Y	2
	Risk Management Process	Y	N	N	Y	Y	3
	Configuration Process						0

: The Processes

Assign Level of Maturity (LOM)



: The Processes

Initiate OrgCap Model

Define: "n" as number of *Enablers;* CRI_i is the Criticality Level of an i^{th} Enabler (where $i = 1, 2, 3, \ldots, n$); M_j is the assigned maturity value of a j^{th} LOM; then the assessed score, $\beta_{A_{ij}}$ is calculated as $\boldsymbol{\beta_{A_{ij}} = CRI_i \times M_j}$

Define: "k" as number of *LOM, then* $j = 1, 2, 3, \ldots, k$). Thus, total assessed composite score, $\boldsymbol{\beta_A}$, for Enablers associated with the j's values is calculated as follow:

$$\boldsymbol{\beta_A = \sum_{i=1}^{n} \sum_{j=1}^{k} CRI_i M_j}$$

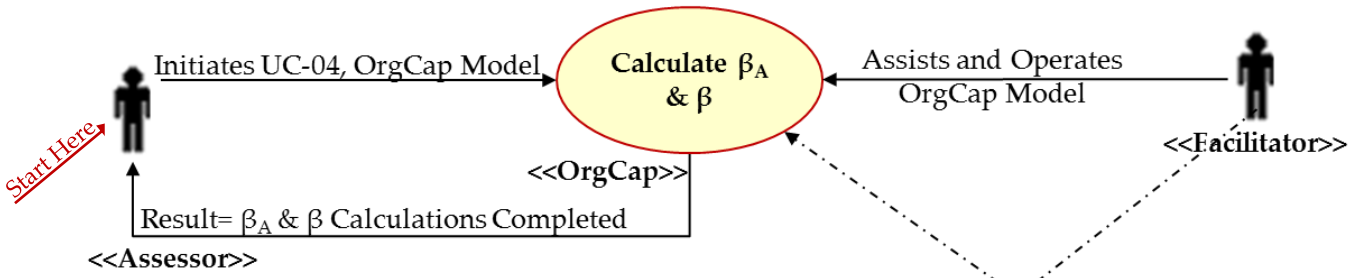
Define: β_D as the desired maturity composite score of n number of Enablers at the **maximum** *LOM, i.e.* $j = k$). Thus, the desired composite score is calculated as follow:

$$\boldsymbol{\beta_D = M_k \sum_{i=1}^{n} CRI_i}$$

Define: β as the normalized maturity index value, and it's calculated as follow:

$$\boldsymbol{\beta = 1 + \frac{\beta_A - \beta_D}{\beta_D}}, \quad \boldsymbol{where\ \beta_D > 0}$$

UC-04: Calculate β_A & β, Using the OrgCap Model



	M_j	j_4	j_3	j_2	j_1	Desired β	
	CRI_i	*Hi=*	*Mo=*	*Lo=*	*Mi=*	*Min*	*Max*
		10	***7***	***4***	***1***	***1***	***10***
Tools	***2***	*0*	*14*	*0*	*0*	2	20
Process	***1***	*10*	*0*	*0*	*0*	1	10
Experience	***4***	*0*	*28*	*0*	*0*	4	40
Funding	***5***	*50*	*0*	*0*	*0*	5	50
Technology	***3***	*30*	*0*	*0*	*0*	3	30
OrgCap Model		***90***	*42*	*0*	***0***	**15**	**150**
		Assessed β_A = 132				*Pick:*	*150*

: The Processes

Initiate CoSh Model

Define: "n" as number of capabilities being assessed; C_i is the Cost performance index of an i^{th} capability (where $i = 1 \ldots n$); C_{actual^i} is the actual $ spent on developing i^{th} capability and $C_{baseline^i}$ is budgeted $ for the same capability; then

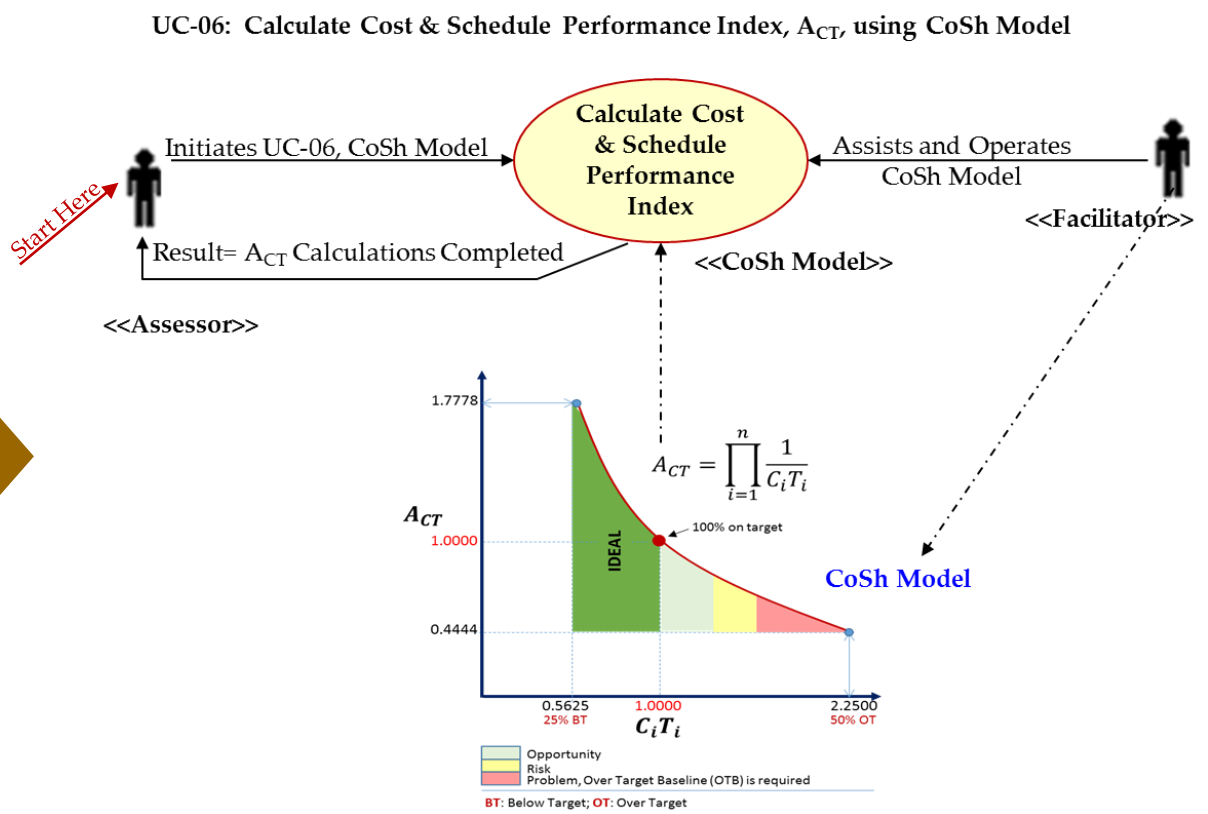
$$C_i = \frac{C_{actual^i}}{C_{baseline^i}} = \begin{cases} < 1, underrun \\ = 1, on\ target \\ > 1, overrun \end{cases}$$

Define: "n" as number of capabilities being assessed; T_i is Schedule performance index of an i^{th} capability (where $i = 1 \ldots n$); T_{actual^i} is the *time* spent on developing i^{th} capability and $T_{baseline^i}$ is allowed *time* for developing the i^{th} capability; then

$$T_i = \frac{T_{actual^i}}{T_{baseline^i}} = \begin{cases} < 1, ahead \\ = 1, on\ track \\ > 1, behind \end{cases}$$

Define: A_{CT} as *affordability risk index* of based upon *cost* and *schedule* performance indices, then A_{CT} is calculated as follow:

$$A_{CT} = \prod_{i=1}^{n} \frac{1}{C_i T_i}, \text{for } C_i > 0 \text{ and } T_i > 0$$



: The Processes

Initiate TecPri Model

Define: "T" as *threshold* value; "A" as *actual* performance value; "NAV" as *normalized actual* performance values; $\frac{1}{NA}$ as *reciprocal of* "NAV"; "Wt" as *weight value assigned to each TPM;* "TRI_{CAT_A}" & "TRI_{CAT_A}" as *technical risk index for Category A & Category B, respectively;* then

Category A:

$$NAV = 1 + \frac{A - T}{T}$$

$$TRI_{CAT\_A} = 1 - [(\sum_{i=1}^{n} Wt_i \frac{1}{NA_i}) \Big/ \sum_{i=1}^{n} Wt_i]$$

Category B:

$$NAV = 1 - \frac{T - A}{T}$$

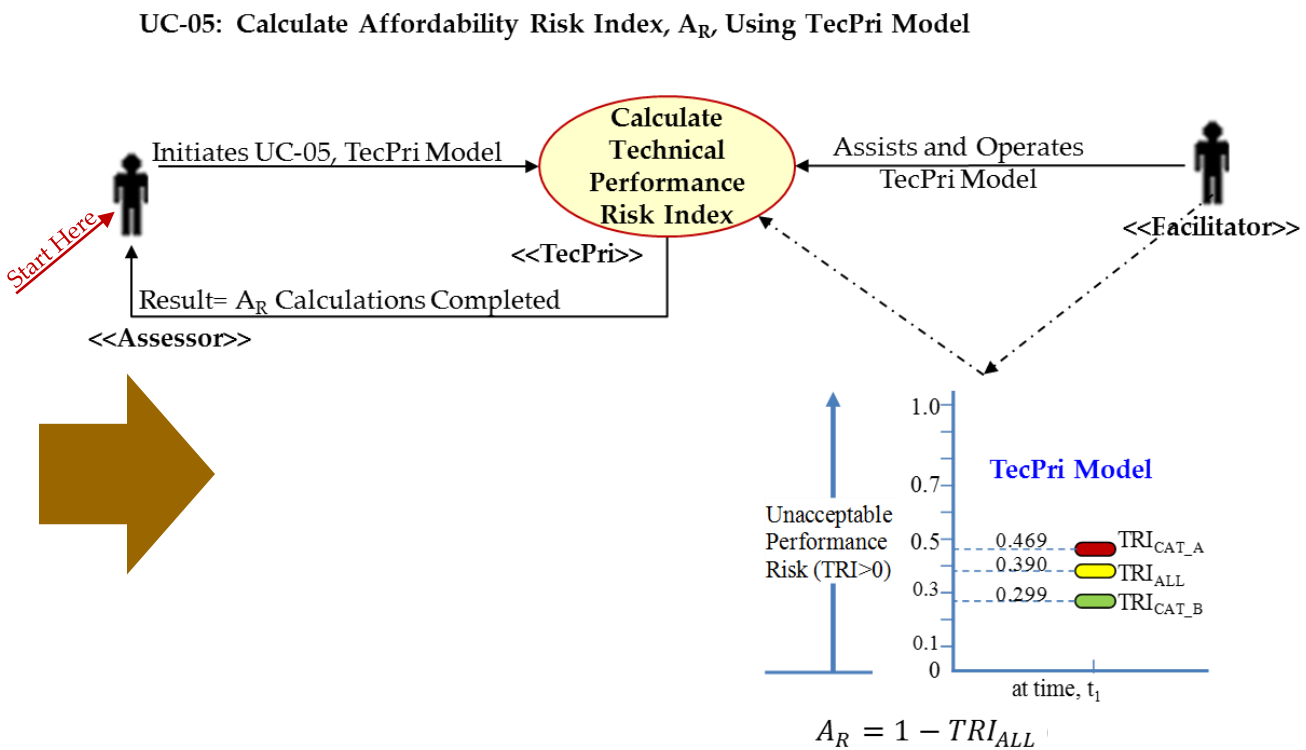
$$TRI_{CAT\_B} = 1 - [(\sum_{i=1}^{n} Wt_i NAV_i) \Big/ \sum_{i=1}^{n} Wt_i]$$

Define: "TRI_{ALL}" as *overall TPMs Risk Index;* then it's calculated as follow:

$$TRI_{ALL} = [Wt*_{CAT_A}.TRI_{CAT_A} + Wt*_{CAT_B}.TRI_{CAT_B}]/(Wt*_{CAT_A} + Wt*_{CAT_B})$$

Define: "A_R" as an *Affordability Risk Index;* then it's calculated as follow:

$$\boldsymbol{A_R = 1 - TRI_{ALL}}$$



: The Processes

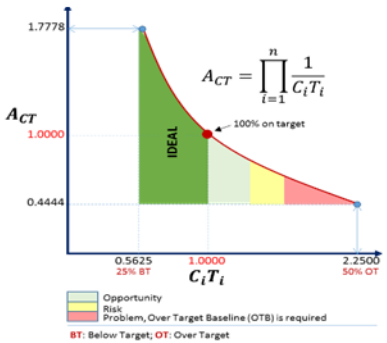
Initiate AMI Model

$$AMI = \beta(1 - TRI_{ALL}) \prod_{i=1}^{n} \frac{1}{C_i T_i}, \text{for } C_i > 0, T_i > 0 = \beta A_R A_{CT}$$

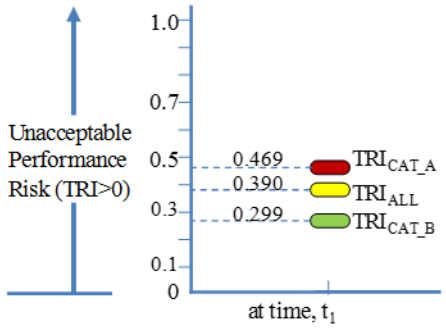
$$A_{CT} = \prod_{i=1}^{n} \frac{1}{C_i T_i}, for\ C_i > 0, T_i > 0$$

$$\beta = 1 + \frac{\beta_A - \beta_D}{\beta_D}$$

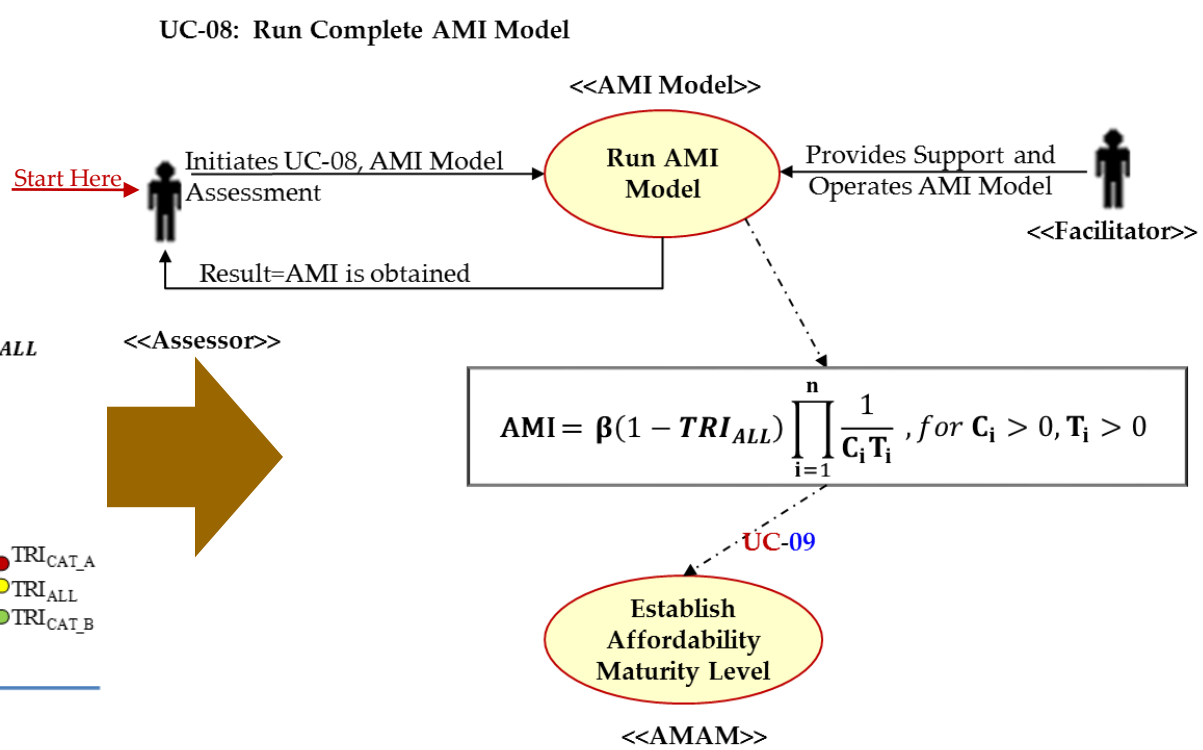
$$A_R = 1 - TRI_{ALL}$$



	M_j	j_4	j_3	j_2	j_1	Desired β	
	CRI_i	Hi=	Mo=	Lo=	Mi=	Min	Max
		10	7	4	1	1	10
Tools	2	0	14	0	0	2	20
Process	1	10	0	0	0	1	10
Experience	4	0	28	0	0	4	40
Funding	5	50	0	0	0	5	50
Technology	3	30	0	0	0	3	30
		90	42	0	0	15	150
		Assessed β_A = 132				Pick:	150

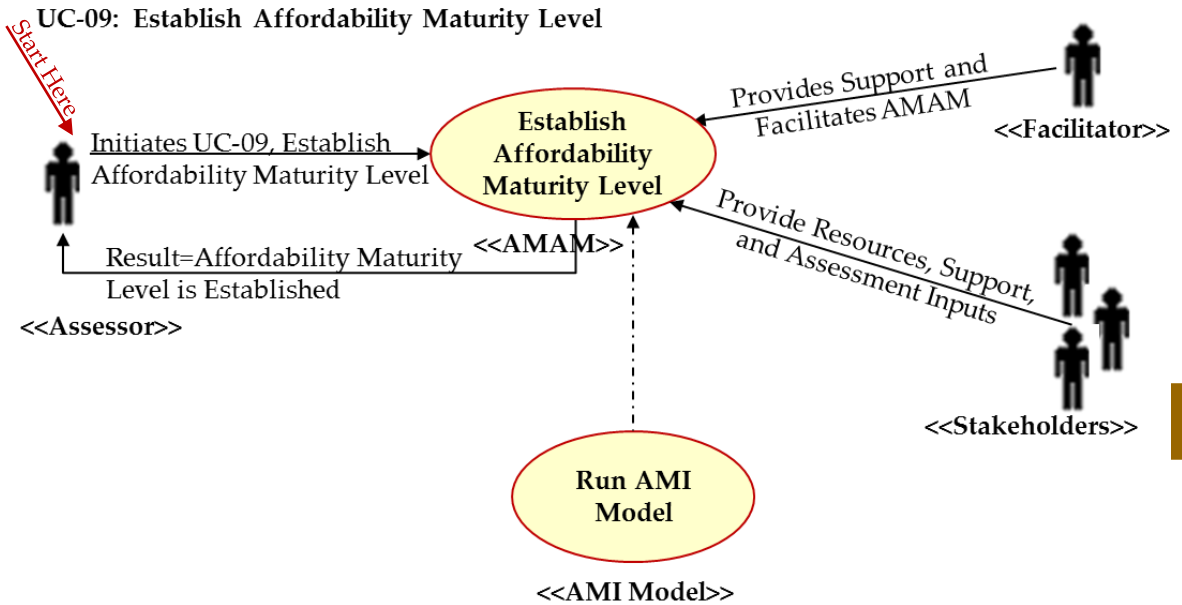


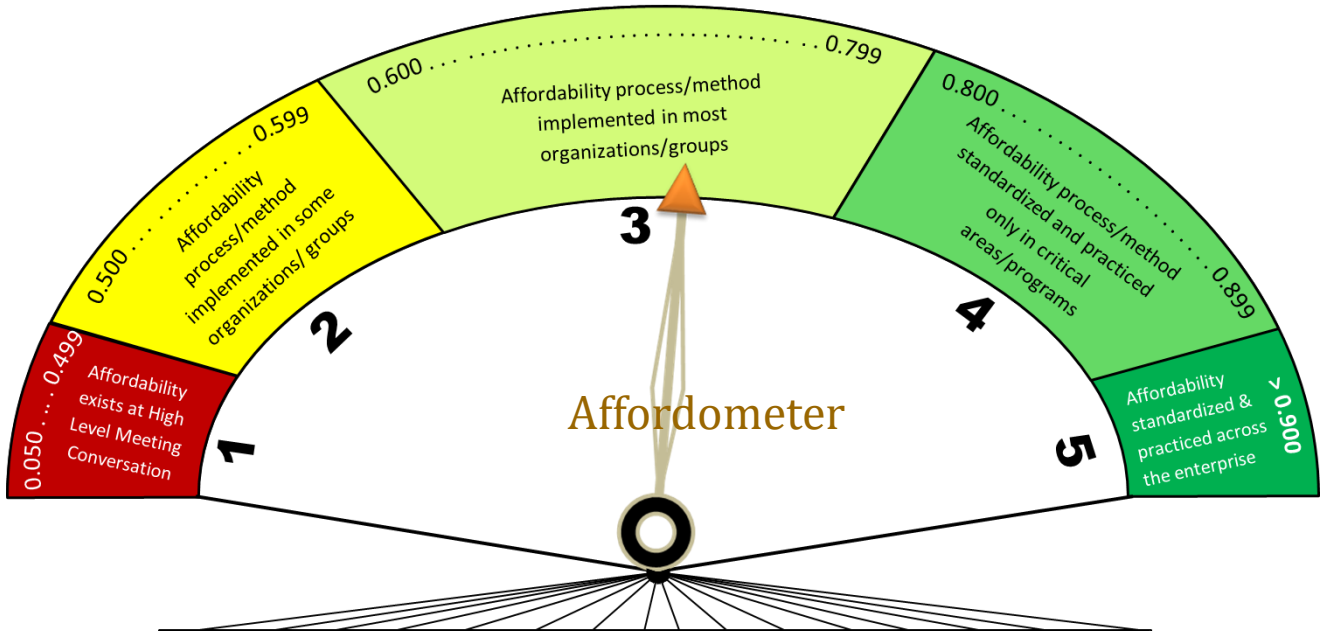
CoSh Model | OrgCap Model | TecPri Model



: The Processes

Establish Affordability Level

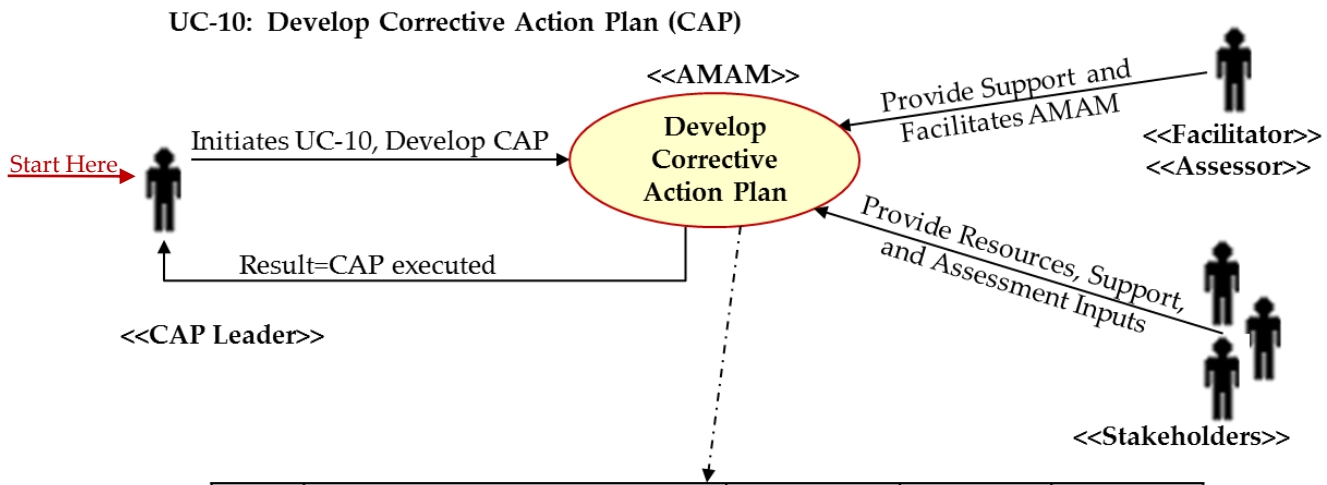




0.9950	0.8500	0.7000	0.5500	0.4000	0.7000	0.5950	0.4900	0.3850	0.2800	0.4000	0.3400	0.2800	0.2200	0.1600
0.9500	0.8075	0.6650	0.5225	0.3800	0.6500	0.5525	0.4550	0.3575	0.2600	0.3500	0.2975	0.2450	0.1925	0.1400
0.9000	0.7650	0.6300	0.4950	0.3600	0.6000	0.5100	0.4200	0.3300	0.2400	0.3000	0.2550	0.2100	0.1650	0.1200
0.8500	0.7225	0.5950	0.4675	0.3400	0.5500	0.4675	0.3850	0.3025	0.2200	0.2500	0.2125	0.1750	0.1375	0.1000
0.8000	0.6800	0.5600	0.4400	0.3200	0.5000	0.4250	0.3500	0.2750	0.2000	0.2000	0.1700	0.1400	0.1100	0.0800
0.7500	0.6375	0.5250	0.4125	0.3000	0.4500	0.3825	0.3150	0.2475	0.1800	0.1500	0.1275	0.1050	0.0825	0.0600

$$\mathbf{AMI} = \beta(1 - TRI_{ALL}) \prod_{i=1}^{n} \frac{1}{C_i T_i}, \text{for } C_i > 0, T_i > 0 = \beta A_R A_{CT}$$

Develop Corrective Action Plan
– *For Improvement Purpose -*



ID	Corrective Action	Start	Finish	POC
0001	Identify Training Requirements	05/27/2017	08/18/2017	J. Pizza
0002	Develop performance risk assessment methodology	05/27/2017	09/02/2017	P. Doves
0003	Identify key cost/schedule drivers for the Z7 weapon integration	05/27/2017	09/21/2017	D. Staffs

Test Case Results

Program Budget:

12,735,148	(Labor hours)
45,000,000	(material $)

Program Description: The International Peace Awareness System (iPAS) is designed to promote trade peace and provide military activities awareness throughout the South East Asia (SEA) to ensure the safety and prosperity for the people in this region.

Program Schedule:	Milestone	Labor Allocation	Material Allocation	Allocated Hrs.	Allocated Dollars
Contract Awarded:	10.31.2013	FFC	FFC	12,735,148	$45,000,000
SRR:	02.28.2014	0.10	0.01	1,273,515	$ 450,000
PDR:	06.31.2014	0.10	0.02	1,273,515	$ 900,000
CDR:	10.31.2014	0.10	0.02	1,273,515	$ 900,000
Implementation:	08.31.2015	0.15	0.10	1,910,272	$ 4,500,000
Verification &Testing:	12.31.2015	0.10	0.10	1,273,515	$ 4,500,000
Prototype:	10.31.2016	0.20	0.25	2,547,030	$11,250,000
1st Production Version:	01.31.2017	0.25	0.50	3,183,787	$22,500,000
Commissioned to Service:	05.20.2017	1.00	1.00	12,735,148	$45,000,000
					Total Allocation

Level	CODE	Maturity Assessment Description
1	A1	Total Program Review is needed
2	A2	Re-planning, Restructuring, Redefining Scope of work
3	A3	Program is on track with moderate risks
4	A4	Program is on track with minimal risks
5	A5	Program is on track in all categories

iPAS SRR Period of Performance: 4 months. Requirement Engineering

11.01.2013 . . . . . .

Start:. . . . . End: 02.28.2014

Hours: 1,273,514.80 Material ($): $ 450,000.00

Program Affordability Maturity Assessment Result: Teams= 4. Phase: SRR

iPAS	WBS	β_A	OrgCap (β)	TecPri (TRi_{ALL})	C	T	CoSh (A_{CT})	AMI	Affordability Maturity Level
TEAM A	A-1000	@ β_D = 150	0.954	#N/A			0.922	0.879	4
	1100	148	0.987	#N/A	1.000	1.000	1.000	0.987	
	1220	147	0.980	#N/A	0.930	1.010	1.065	1.043	
	1300	148	0.987	#N/A	1.050	1.100	0.866	0.854	
TEAM B	B-2000	@ β_D = 170	0.954	#N/A			0.747	0.712	3
	2100	168	0.988	#N/A	0.990	1.000	1.010	0.998	
	2200	166	0.976	#N/A	1.000	0.980	1.020	0.996	
	2300	168	0.988	#N/A	1.200	1.150	0.725	0.716	
TEAM C	C-3000	@ β_D = 210	0.930	#N/A			0.836	0.778	3
	3100	205	0.976	#N/A	0.980	1.200	0.850	0.830	
	3200	206	0.981	#N/A	0.990	1.000	1.010	0.991	
	3300	208	0.990	#N/A	0.970	1.000	1.031	1.021	
	3400	206	0.981	#N/A	0.990	1.070	0.944	0.926	
TEAM D	D-4000	@ β_D = 145	0.966	#N/A			1.118	1.080	5
	4100	144	0.993	#N/A	0.970	0.980	1.052	1.045	
	4200	142	0.979	#N/A	1.000	0.990	1.010	0.989	
	4300	144	0.993	#N/A	0.970	0.980	1.052	1.045	
TEAM E, F, G, H, & I	E-5000	β_A = β_D	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	5100		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
	F-6000	β_A = β_D	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	6100		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
	G-7000	β_A = β_D	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	7100		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
	H-8000	β_A = β_D	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	8100		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
	I-9000	β_A = β_D	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
	9100		#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
PROGRAM			0.951				0.861	0.819	4

SRR=System Readiness Review; PDR=Preliminary Design Review; CDR=Critical Design Review

Technical performance data not available during SRR to apply TecPri model

Team E-I do not perform Requirements Development/Engineering

iPAS PDR Period of Performance: 4 months. Preliminary Design (PD)

03.01.2014 . . . . . .

Start:. . . . . End: 06.31.2014

Hours: 1,273,514.80 Material ($): $ 900,000.00

Program Affordability Maturity Assessment Result: Teams= 9. Phase: PDR

iPAS	WBS	β_A	OrgCap (β)	TecPri (TRi_{ALL})	TecPri (A_R)	C	T	CoSh (A_{CT})	AMI	Affordability Maturity Level
TEAM A	A-1000	@ β_D = 150	0.866		0.951			0.966	0.796	3
	1100	143	0.953	0.010	0.990	1.000	1.000	1.000	0.953	
	1220	141	0.940	0.030	0.970	1.000	0.995	1.005	0.945	
	1300	145	0.967	0.010	0.990	1.040	1.000	0.962	0.929	
TEAM B	B-2000	@ β_D = 170	0.828		0.937			1.031	0.799	3
	2100	165	0.971	0.009	0.991	1.000	0.980	1.020	0.990	
	2200	159	0.935	0.050	0.950	0.990	1.000	1.010	0.945	
	2300	155	0.912	0.005	0.995	1.000	1.000	1.000	0.912	
TEAM C	C-3000	@ β_D = 210	0.790		0.964			0.772	0.589	2
	3100	200	0.952	0.010	0.990	1.000	1.100	0.909	0.866	
	3200	198	0.943	0.010	0.990	1.000	1.000	1.000	0.943	
	3300	199	0.948	0.008	0.992	1.000	1.000	1.000	0.948	
	3400	195	0.929	0.008	0.992	1.070	1.100	0.850	0.789	
TEAM D	D-4000	@ β_D = 145	0.825		0.951			1.052	0.825	4
	4100	135	0.931	0.020	0.980	1.000	0.980	1.020	0.950	
	4200	133	0.917	0.020	0.980	1.000	0.990	1.010	0.927	
	4300	140	0.966	0.010	0.990	1.000	0.980	1.020	0.985	
E	E-5000	β_A = 95	0.895		0.992			1.000	0.888	4
	5100	85	0.895	0.008	0.992	1.000	1.000	1.000		
F	F-6000	β_A = 95	0.895		0.992			1.000	0.888	4
	6100	85	0.895	0.008	0.992	1.000	1.000	1.000		
TEAM G, H, & I	G-7000	β_A = β_D	#N/A	#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
	7100	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
	H-8000	β_A = β_D	#N/A	#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
	8100	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
	I-9000	β_A = β_D	#N/A	#N/A	#N/A	#N/A		#N/A	#N/A	#N/A
	9100	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	
PROGRAM			0.850		0.8036			0.785	0.536	2

SRR=System Readiness Review; PDR=Preliminary Design Review; CDR=Critical Design Review

Technical performance data is minimal during PDR. Legacy knowledge & performance data used to guide PD for iPAS

Team G, H & I do not perform PDR task

END OF PRESENTATION