Program-Awareness via Lexical Link Analysis (LLA)

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Research Questions

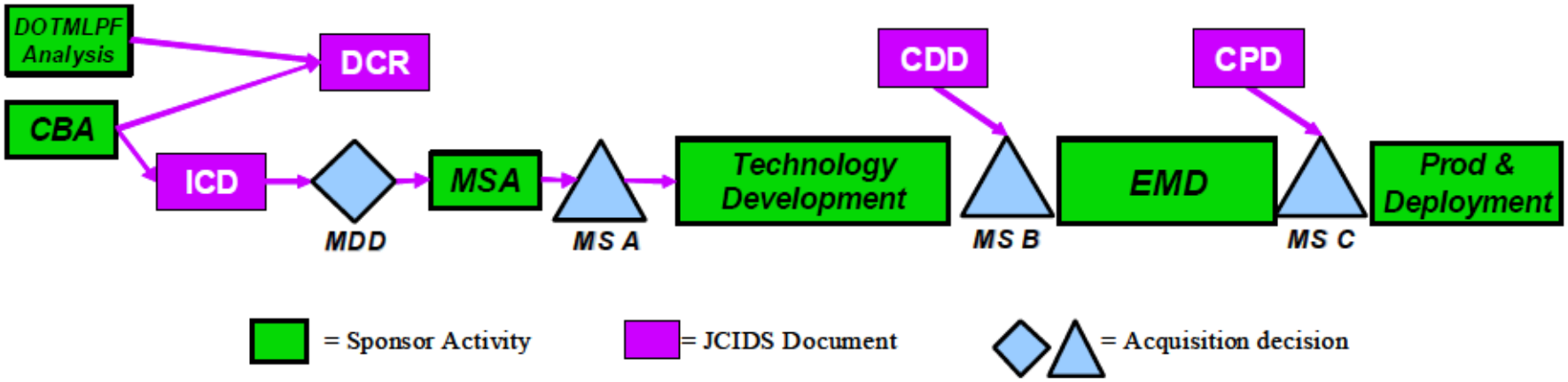
Conceptual: 1) Can the information that emerges from the acquisition process be used to produce overall *awareness* of the *fit* between programs/projects/systems and *needs* for which they were intended?. 2) If a higher level of *awareness* is possible, will that enable system level regulation of programs/projects/systems for improvement of the acquisition system?

Focused: 1) Based on the normal evolution of documentation and current data-based program information, can requirements (needs) be connected to system capabilities? 2) Can requirements gaps be revealed?

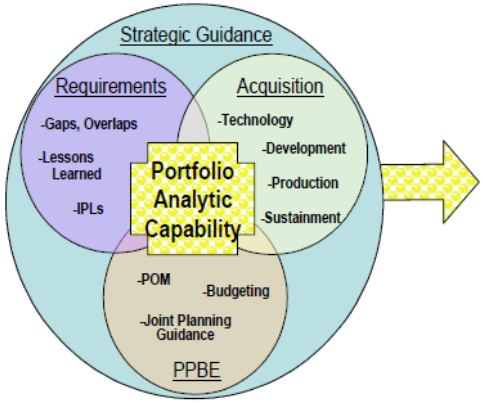
Theory development: Is there a correlation between system interdependency (links/relationships) and development costs?

Methodology: Is it possible to use natural language and other documentation (roughly, unformatted data) to produce visualization of the internal constructs useful for management, through lexical link analysis (LLA)?

Critical Need: Automation



JCIDS Process and Acquisition Decisions
(From J-8 CJCSI 3170.01G)(JCIDS, 2009)



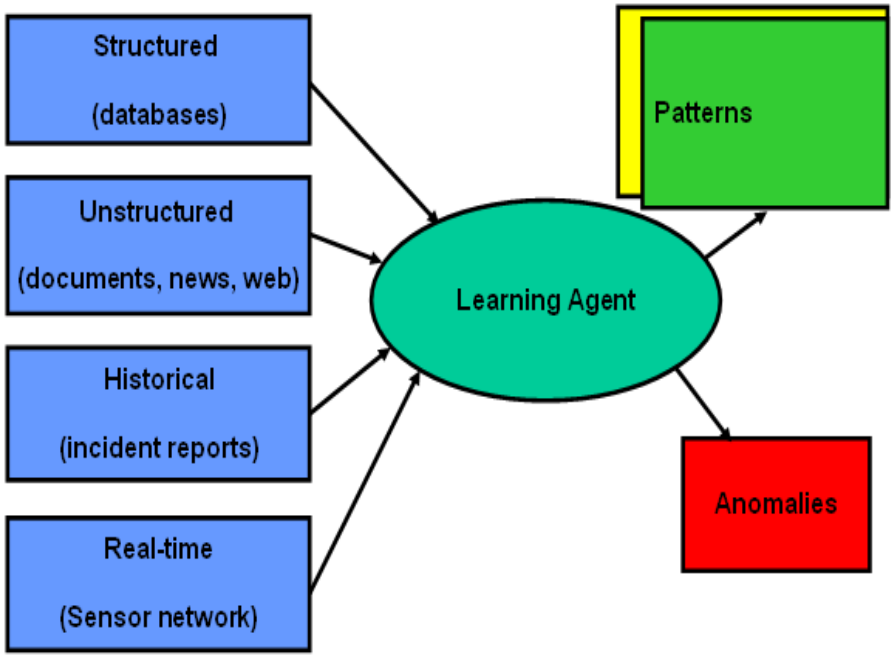
Multiple Portfolio Views:
- Systems vs. Capabilities
- Investment vs. Capabilities
- System Context
- Highly dependent programs (Joint Enablers)
- Procurement Optimization
- S&T vs. future needs
- Sustainment Efficiency
- Market Value

- Data is too voluminous, unformatted and unstructured!
- Need automation
  - Extract relations among PE, MDAP and ACATII
  - Extract costs

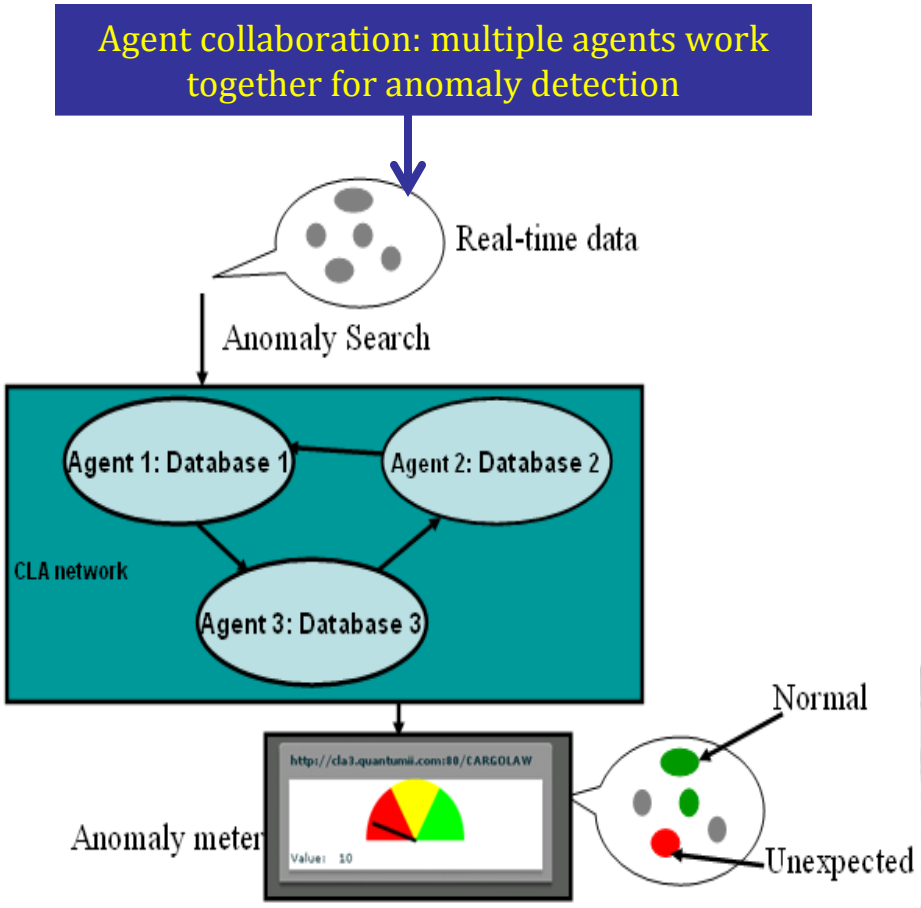
LLA for Analysis of Unstructured Data

- Apply Collaborative Learning Agents
  - Separate patterns and anomalies
  - Parallel computing using NPS High Performance Center (HPC)
- Develop Visualization
  - AutoMap
  - Radar
  - Matrix
- Conduct Pre-processing Steps
  - Named Entity Extraction
    - Leave out people, places and organizations
  - Parts of Speech Tagging
    - Separate nouns, verbs, adjectives, adverbs

Apply Learning Agents to Perform LLA



A learning agent ingests structured, unstructured, historical or real-time data and separate patterns and anomalies.



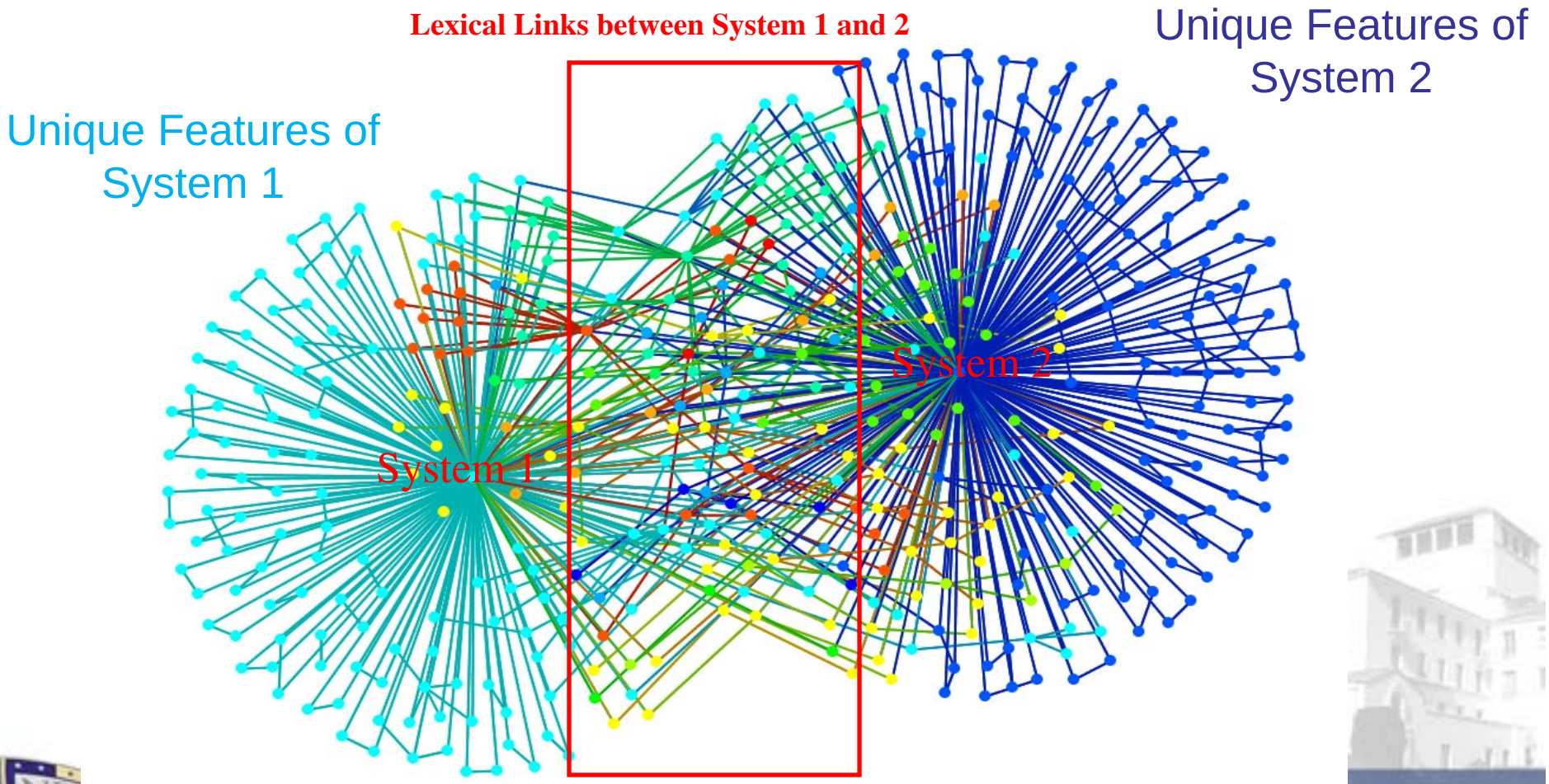
What is a learning agent?

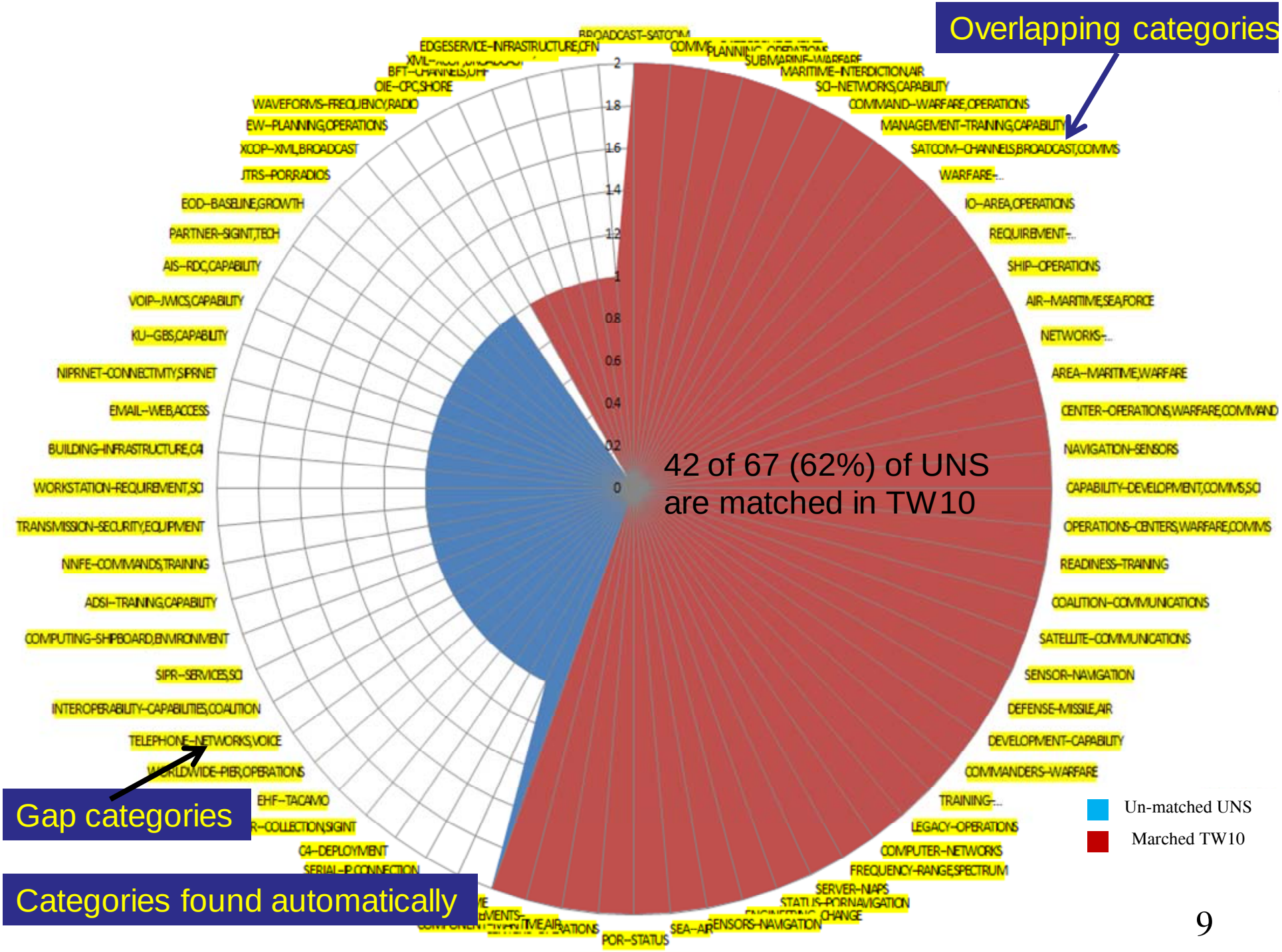
- A computer program or software
  - Installed in a computer with permission
  - Perform automatic tasks
- Multi-agent, distributed networks are capable of
  - Self-managing (Hinchey et al, 2006)
  - Self-healing (Dashofy et al, 2002)
  - Self-optimizing, self-configuring, self-adapting…
- Our learning agent
  - Related to
    - Reinforcement learning (Sutton 1998)
    - Bayesian belief networks (Pearl, 1986; Ben-Gal, 2007)
    - Hidden Markov Models (Huang 1990)
  - Learning patterns and anomalies

Example
Analysis of Urgent Need Statements (UNS)

- Analyzed three lists of classified needs statements and links to Trident Warrior 10 technology capabilities
  - Navy classified UNS
  - C5F (5th Fleet)
  - Integrated Priority List (IPL)
    - CENTCOM and NAVCENT
- Validity checked by Subject Matter Experts

Visualization



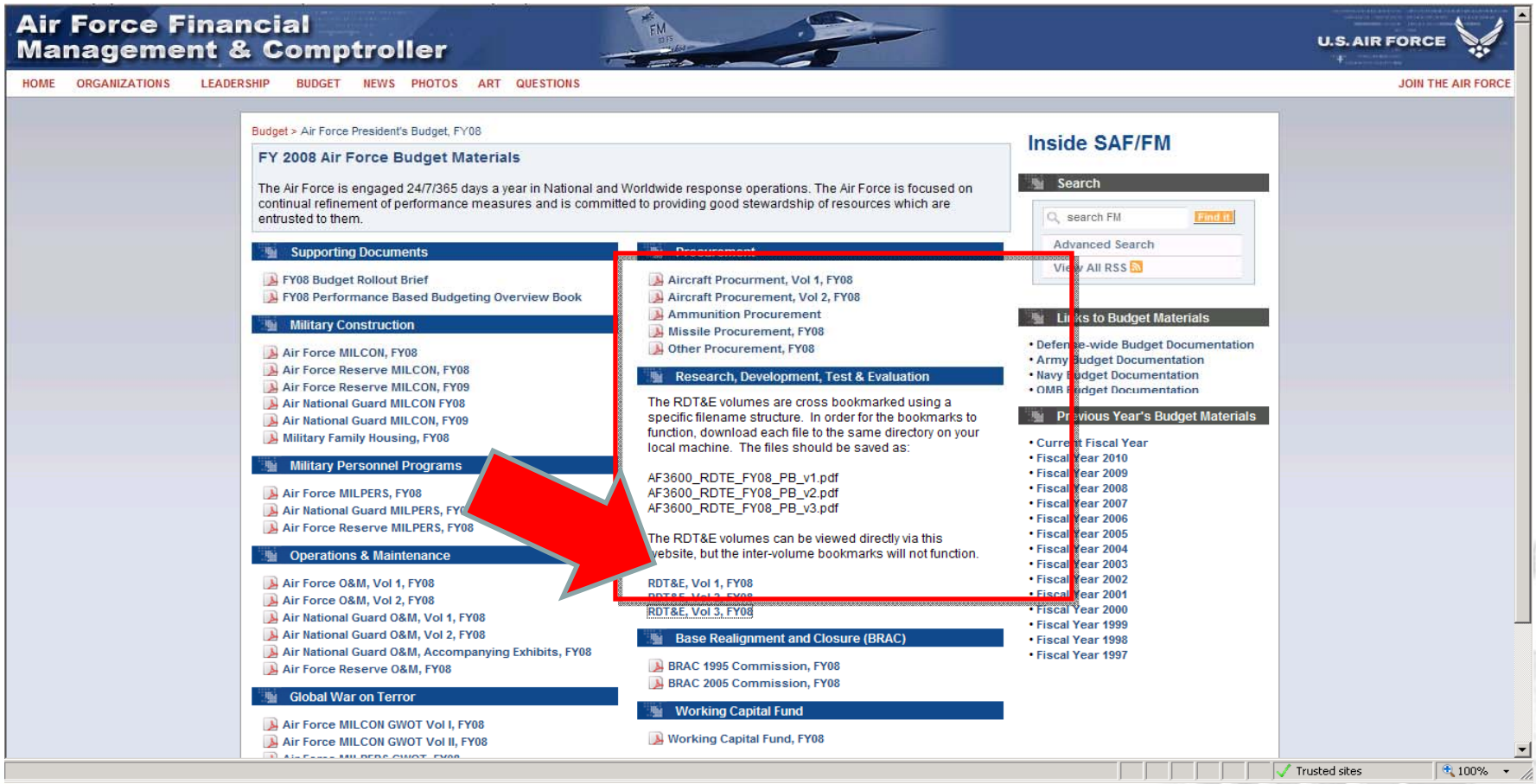

Overlapping categories
42 of 67 (62%) of UNS are matched in TW10
Gap categories
Categories found automatically
Un-matched UNS
Marched TW10
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
EDGESERVICE–INFRASTRUCTURE,CFN
OIE–CPC,SHORE
WAVEFORMS–FREQUENCY,RADIO
EW–PLANNING,OPERATIONS
XCOP–XIVIL,BROADCAST
JTRS–POR,RADIOS
EOD–BASELINE,GROWTH
PARTNER–SIGINT,TECH
AIS–RDC,CAPABILITY
VOIP–JWICS,CAPABILITY
KU–GBS,CAPABILITY
NIPRNET–CONNECTIVITY,SIPRNET
EMAIL–WEB,ACCESS
BUILDING–INFRASTRUCTURE,C4
WORKSTATION–REQUIREMENT,SCI
TRANSMISSION–SECURITY,EQUIPMENT
NNFE–COMMANDS,TRAINING
ADSI–TRAINING,CAPABILITY
COMPUTING–SHIPBOARD,ENVIRONMENT
SIPR–SERVICES,SCI
INTEROPERABILITY–CAPABILITIES,COALITION
TELEPHONE–NETWORKS,VOICE
EHF–TACAMO
C4–DEPLOYMENT
SERIAL–IP,CONNECTION
POR–STATUS
SEA–AIR
SENSORS–NAVIGATION
SERVER–NAPS
COMPUTER–NETWORKS
FREQUENCY–RANGE,SPECTRUM
LEGACY–OPERATIONS
TRAINING–...
COMMANDERS–WARFARE
DEVELOPMENT–CAPABILITY
DEFENSE–MISSILE,AIR
SENSOR–NAVIGATION
SATELLITE–COMMUNICATIONS
COALITION–COMMUNICATIONS
READINESS–TRAINING
OPERATIONS–CENTERS,WARFARE,COMMS
CAPABILITY–DEVELOPMENT,COMMS,SCI
NAVIGATION–SENSORS
CENTER–OPERATIONS,WARFARE,COMMAND
AREA–MARITIME,WARFARE
NETWORKS–...
AIR–MARITIME,SEA,FORCE
SHIP–OPERATIONS
REQUIREMENT–...
IO–AREA,OPERATIONS
WARFARE–...
SATCOM–CHANNELS,BROADCAST,COMMS
MANAGEMENT–TRAINING,CAPABILITY
COMMAND–WARFARE,OPERATIONS
SCI–NETWORKS,CAPABILITY
MARITIME–INTERDICTION,AIR
SUBMARINE–WARFARE

Large Scale Data

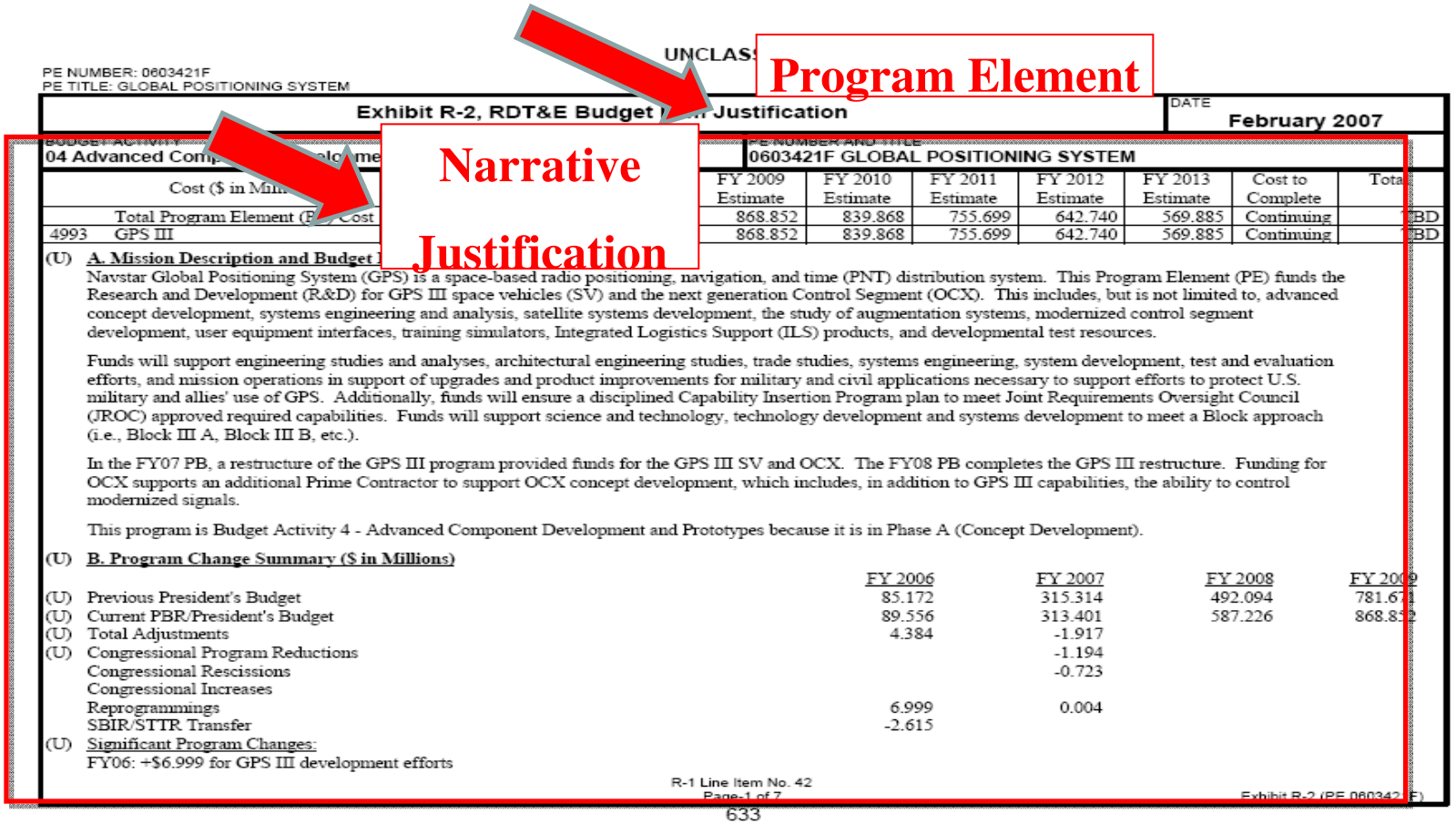
- Program Elements
- Programs
  - Major DOD Acquisition Programs (MDAP)
  - Acquisition Category II (ACAT II)
- UJTLS
- Source
  - Rob Flowe OUSD(AT&L)/ARA/EI

DOD Program Elements

http://comptroller.defense.gov/defbudget/fy2009/index.html



PE Narrative Justification



UNCLAS

PE NUMBER: 0603421F
PE TITLE: GLOBAL POSITIONING SYSTEM

Program Element

Exhibit R-2, RDT&E Budget [illegible] Justification

DATE
February 2007

Narrative

Justification

BUDGET ACTIVITY
04 Advanced Comp[illegible]

PE NUMBER AND TITLE
0603421F GLOBAL POSITIONING SYSTEM

Cost ($ in Mil[illegible]	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	Cost to Complete	Tota
Total Program Element (P[illegible] Cost	868.852	839.868	755.699	642.740	569.885	Continuing	TBD
4993 GPS III	868.852	839.868	755.699	642.740	569.885	Continuing	TBD

(U) **A. Mission Description and Budget [illegible]**

Navstar Global Positioning System (GPS) is a space-based radio positioning, navigation, and time (PNT) distribution system. This Program Element (PE) funds the Research and Development (R&D) for GPS III space vehicles (SV) and the next generation Control Segment (OCX). This includes, but is not limited to, advanced concept development, systems engineering and analysis, satellite systems development, the study of augmentation systems, modernized control segment development, user equipment interfaces, training simulators, Integrated Logistics Support (ILS) products, and developmental test resources.

Funds will support engineering studies and analyses, architectural engineering studies, trade studies, systems engineering, system development, test and evaluation efforts, and mission operations in support of upgrades and product improvements for military and civil applications necessary to support efforts to protect U.S. military and allies' use of GPS. Additionally, funds will ensure a disciplined Capability Insertion Program plan to meet Joint Requirements Oversight Council (JROC) approved required capabilities. Funds will support science and technology, technology development and systems development to meet a Block approach (i.e., Block III A, Block III B, etc.).

In the FY07 PB, a restructure of the GPS III program provided funds for the GPS III SV and OCX. The FY08 PB completes the GPS III restructure. Funding for OCX supports an additional Prime Contractor to support OCX concept development, which includes, in addition to GPS III capabilities, the ability to control modernized signals.

This program is Budget Activity 4 - Advanced Component Development and Prototypes because it is in Phase A (Concept Development).

(U) **B. Program Change Summary ($ in Millions)**

	FY 2006	FY 2007	FY 2008	FY 2009
(U) Previous President's Budget	85.172	315.314	492.094	781.67[illegible]
(U) Current PBR/President's Budget	89.556	313.401	587.226	868.85[illegible]
(U) Total Adjustments	4.384	-1.917		
(U) Congressional Program Reductions		-1.194		
Congressional Rescissions		-0.723		
Congressional Increases				
Reprogrammings	6.999	0.004		
SBIR/STTR Transfer	-2.615			

(U) Significant Program Changes:
FY06: +$6.999 for GPS III development efforts

R-1 Line Item No. 42
Page-1 of 7
Exhibit R-2 (PE 060342[illegible]F)

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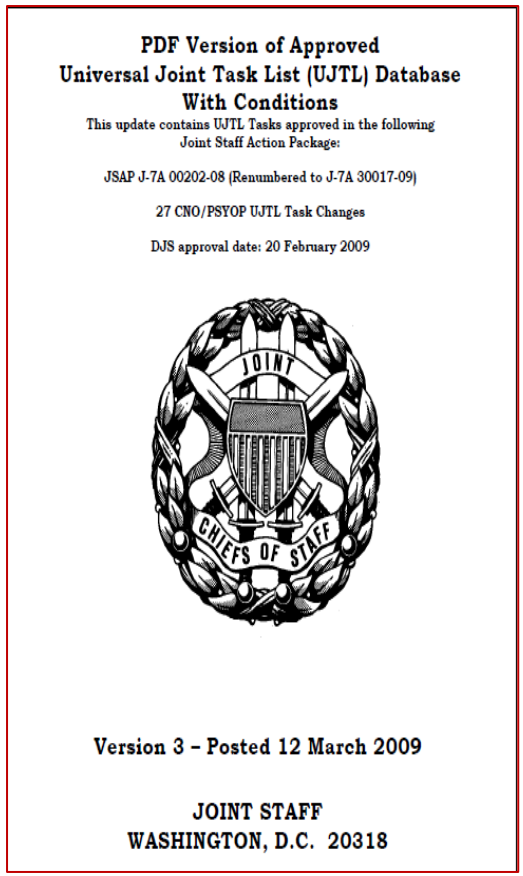
Acquisition Documents


PDF Version of Approved
Universal Joint Task List (UJTL) Database
With Conditions
This update contains UJTL Tasks approved in the following
Joint Staff Action Package:

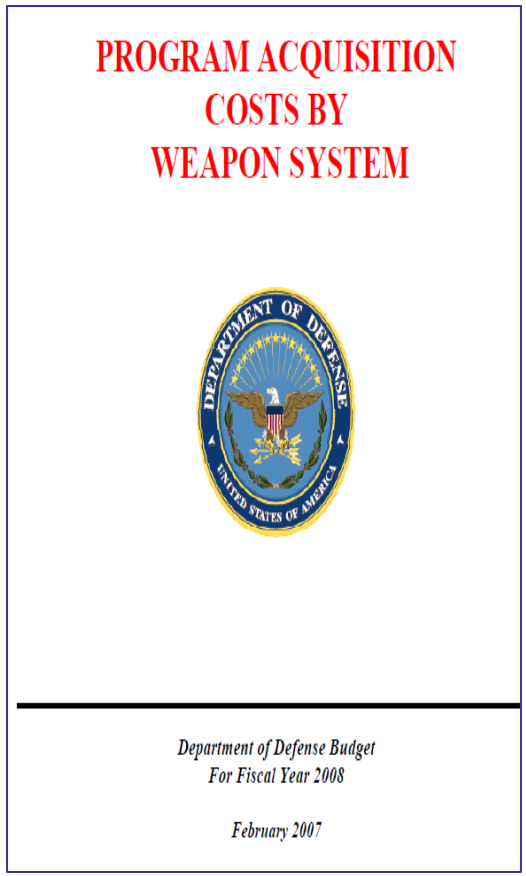
JSAP J-7A 00202-08 (Renumbered to J-7A 30017-09)

27 CNO/PSYOP UJTL Task Changes

DJS approval date: 20 February 2009

Version 3 – Posted 12 March 2009

JOINT STAFF
WASHINGTON, D.C. 20318

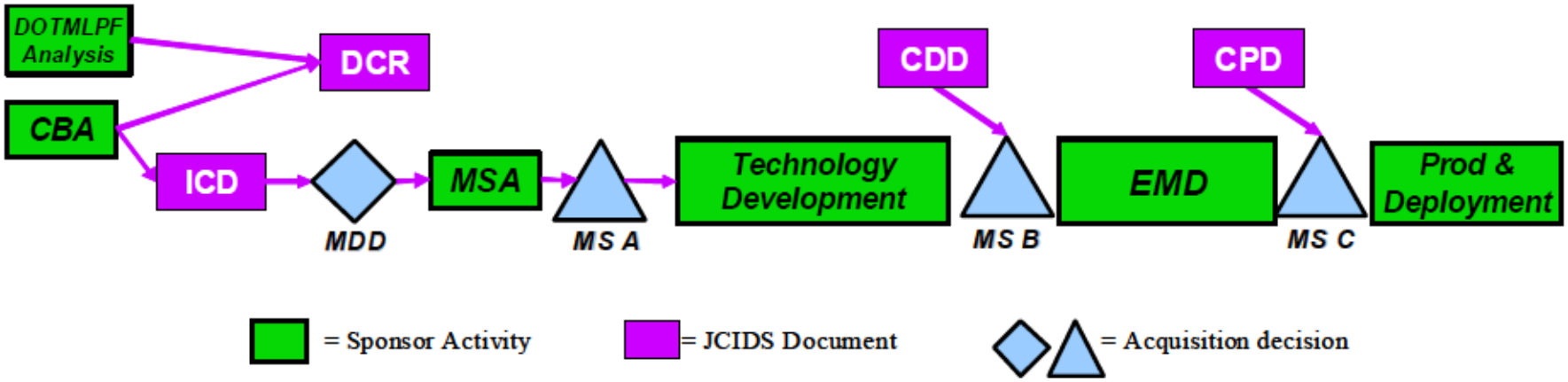

PROGRAM ACQUISITION
COSTS BY
WEAPON SYSTEM

Department of Defense Budget
For Fiscal Year 2008

February 2007

- Program Elements: RDTE books
  - Air Force
  - Army
    - http://asafm.army.mil/Document.aspx?OfficeCode=1200
  - Navy
    - http://www.finance.hq.navy.mil/fmb/11pres/BOOKS.htm
- Universal Joint Task List
- Weapon Books

Critical Need: Automation



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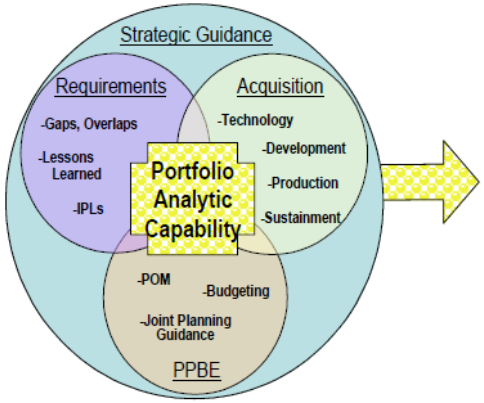

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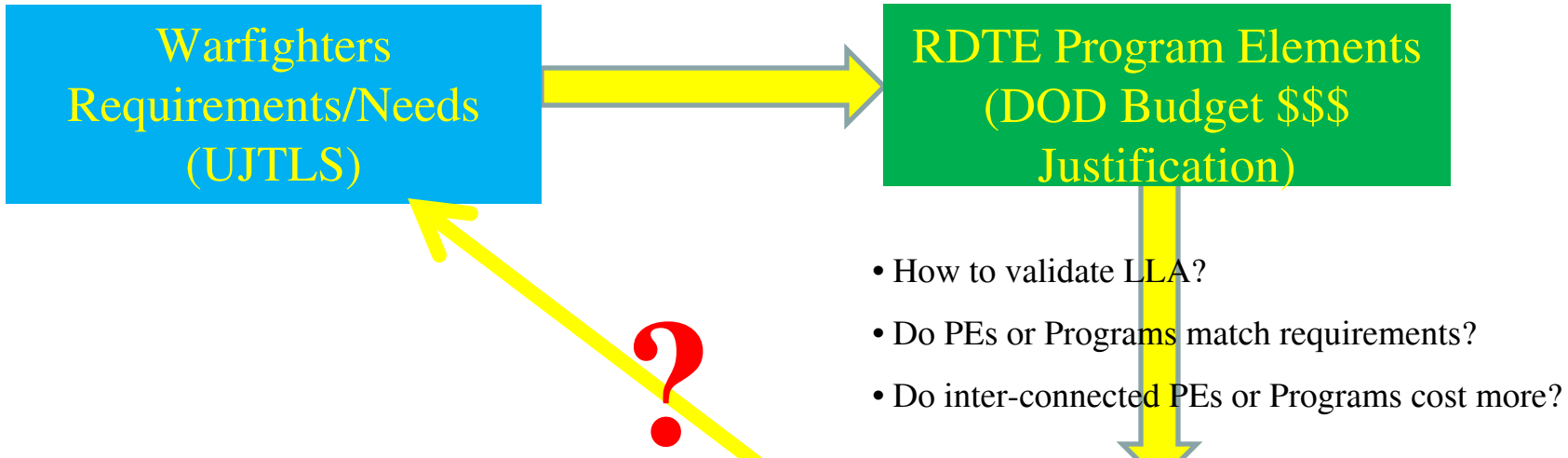
LLA Methodology Can Help!



LLA automates the possibility to develop awareness of the "fit" between PE's, budget and warfighter requirements.

PE Links Identified by Human Analysts (Used for LLA Validation)

UNCLASSIFI

Exhibit R-2a, RDT&E Project Justifica

DATE: May 2009

BUDGET ACTIVITY: 05 System Development and Demonstration (SDD)

PE N R AND TITLE: 060460 2F Armament/Ordnance Development

PROJECT NUMBER AND TITLE: 5361 Stores-Aircraft Interface

Cost ($ in Millions)	FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY Esti	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost to Complete	Total
5361 Stores-Aircraft Interface	0.000	0.000	6.685		0.000	0.000	0.000	0.000	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

In FY 2010, Project 5361, Stores-Aircraft Interface (new), efforts were transferred from PE 0605011F, RDT&E for Aging Aircraft, Project 654685, Universal Armament Interface (UAI), in order to properly fund the maturing technology.

(U) **A. Mission Description and Budget Item Justification**

Universal Armament Interface (UAI) is an Air Force initiative to develop, enhance, and implement standardized interfaces in aircraft, weapons and mission planning to support integration of weapons independent of aircraft Operation Flight Program (OFP) cycles. UAI is currently being implemented on the F-15E and F-16 Block 40/50 aircraft, Small Diameter Bomb (SDB) I and II, Joint Direct Attack Munition (JDAM), Joint Air-to-Surface Stand-off Missile (JASSM) and Precision Guided Munitions Planning Software (PGMPS). Additional aircraft and weapons have program plans to implement UAI. The UAI program office is responsible for development and enhancement of the standard, provision of certification tools (test assets) and implementation support to aircraft and weapons.

The UAI efforts were transferred (1) to ensure continued funding for UAI through the FYDP (PE 0605011F will be zeroed out in FY 2010 due to higher Air Force priorities), and (2) to properly fund the maturing technology. The new project number is established to provide greater visibility into UAI's budget. Funding UAI via the Arm/Ord PE will ensure that platform and weapon program offices have the support required to implement and update UAI.

This program is in Budget Activity 5 - System Development and Demonstration (SDD) because it supports armament integration, an SDD-type activity.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2008	FY 2009	FY 2010
(U) ICD Dev/Updates			5.702
(U) UAI Common Component			0.786
(U) Certification Tool			0.197
(U) Total Cost	0.000	0.000	6.685

This is not a new start; these efforts were performed under PE 0605011F, RDT&E for Aging Aircraft, in FY 2008 and FY 2009.

0604602F references 0605011F Forward Link

0605011F referenced by 0604602F Backward Link

(U) **C. Other Program Funding Summary ($ in Millions)**

FY 2008 Actual	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	FY 2012 Estimate	FY 2013 Estimate	FY 2014 Estimate	FY 2015 Estimate	Cost to Complete	Total Cost

(U) N/A

(U) **D. Acquisition Strategy**

In December 2004, under the authority of a class Justification and Approval (J&A), the UAI program office awarded individual Cost Plus Fixed Fee (CPFF) contracts to Boeing, Lockheed-Martin, Northrop-Grumman and Raytheon. These four vendors are the Original Equipment Manufacturers (OEMs) for approximately 90% of the Department of Defense' platforms and weapons. Each OEM is responsible for a different piece of the total UAI requirement based on its platform or weapon expertise.

Project 5361 | R-1 Line Item No. 77 Page-9 of 13 | Exhibit R-2a (PE 0604602F)

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Validate LLA and Discover Statistically Significant Correlation

PEs

	0101113F	0101122F	0101221N	0101226N	0101313F
0204413N	36,PROFILE,CONTROLLER,ARTICLES,TACTICAL,FUNCTIONAL,TRANSFERS,DIGITAL	D,BLANK,PERFORMED,INTENTIONALLY,ELECTRICAL,ARTICLES,FUNCTIONAL,ACCO	D,BLANK,SUPT,NAVY,TRANSITION,INTENTIONALLY,DIGITAL,CONTRACTS,ARTICLES	S,INITIATIVES,METRICS,SUBTOTAL,TRANSFERS,TOTALS,PRIOR,READINESS,CATEG	TIONALLY,CONTRVES,TACTICAL
0204571N	NERSHIP,DEVICES,OBSOLESCENCE,NAVIGATION,SUPPORTED,DAMAGE,IDENTIFIE	VIGATION,IDENTIFIED,PROFILE,ALTERNATIVES,UTILIZING,STRIKE,MODIFICATIONS	LEET,CYCLE,DEVICES,OBSOLESCENCE,NAVIGATION,IDENTIFIED,COMMENCE,SUPP	E,UNCLASSIFIED,LOOP,COUNTERMEASURE,FACILITY,ENGINEERING,MILESTONE,RE	TION,DEFINED,LE,EVALUATIONS,T
0204574N	TION,REPORTING,INTEGRATED,MANUFACTURING,ENHANCEMENTS,DEVELOPS,AR	ANK,INTENTIONALLY,ARTICLES,INVENTORY,PRIOR	EMERGENT,CERTIFICATION,UNCLASSIFIED,TESTED,INTEGRATED,SUBSURFACE,BLA	ELOPS,ARTICLES,METRICS,SUBTOTAL,TRANSFERS,DEC,TOTALS,PRIOR,CATEGORY,Q	PLOYMENT,INTEGENTATION,STRAT
LLA:# of Matched Word Hubs	261	88	413	54	
LLA: Overall Match Score	156125	63013	326240	32278	
LLA:# of Unique Word Hubs					
PE Forward Links	1				
PE Backward Links	1		1		
PE Links(Forward+Backward)	2	0	1	0	
2009 Cost	38651	[illegible]	[illegible]	[illegible]	
	0.396594525				

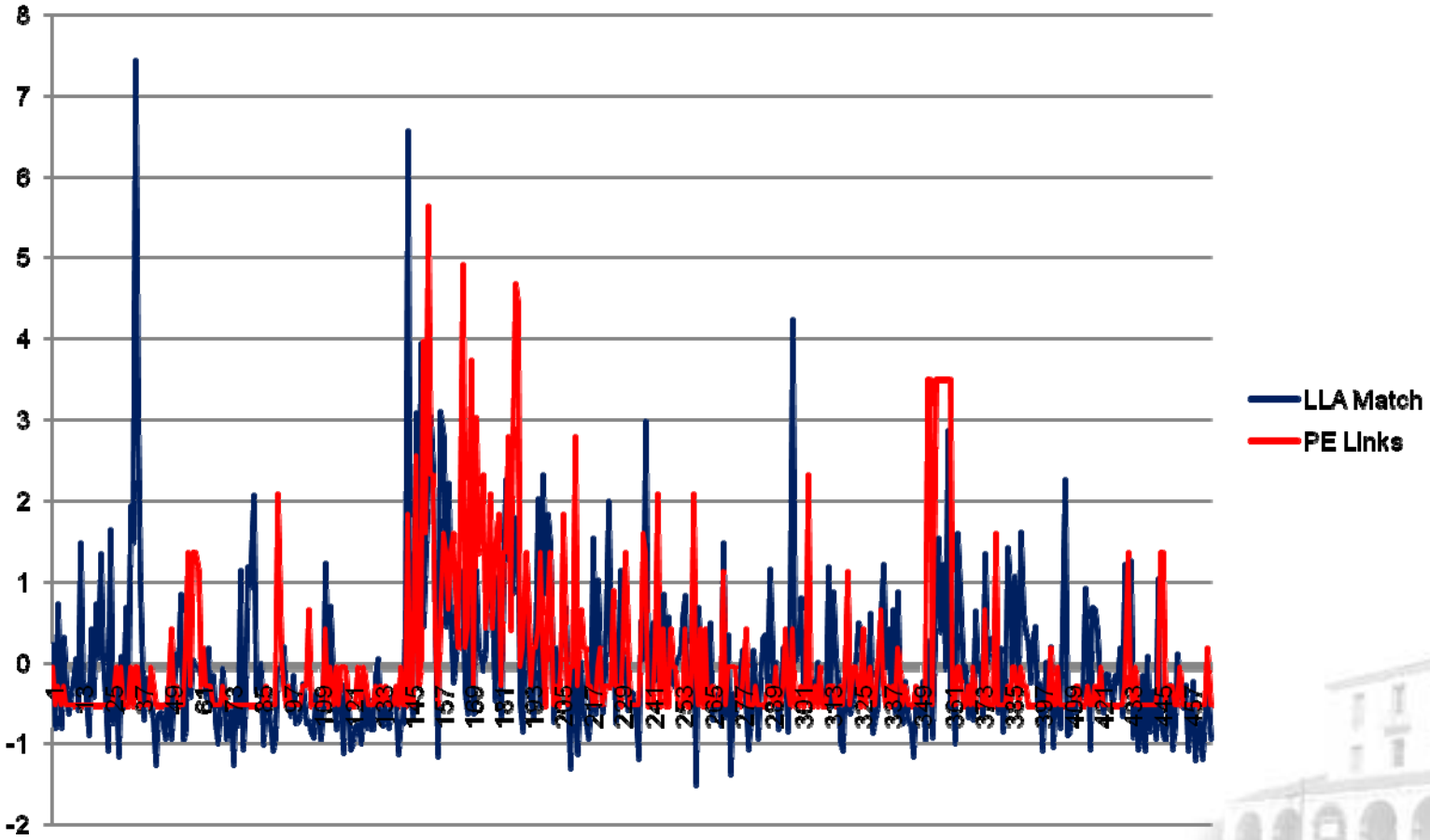
PEs

From LLA using the narrative descriptions of each PE

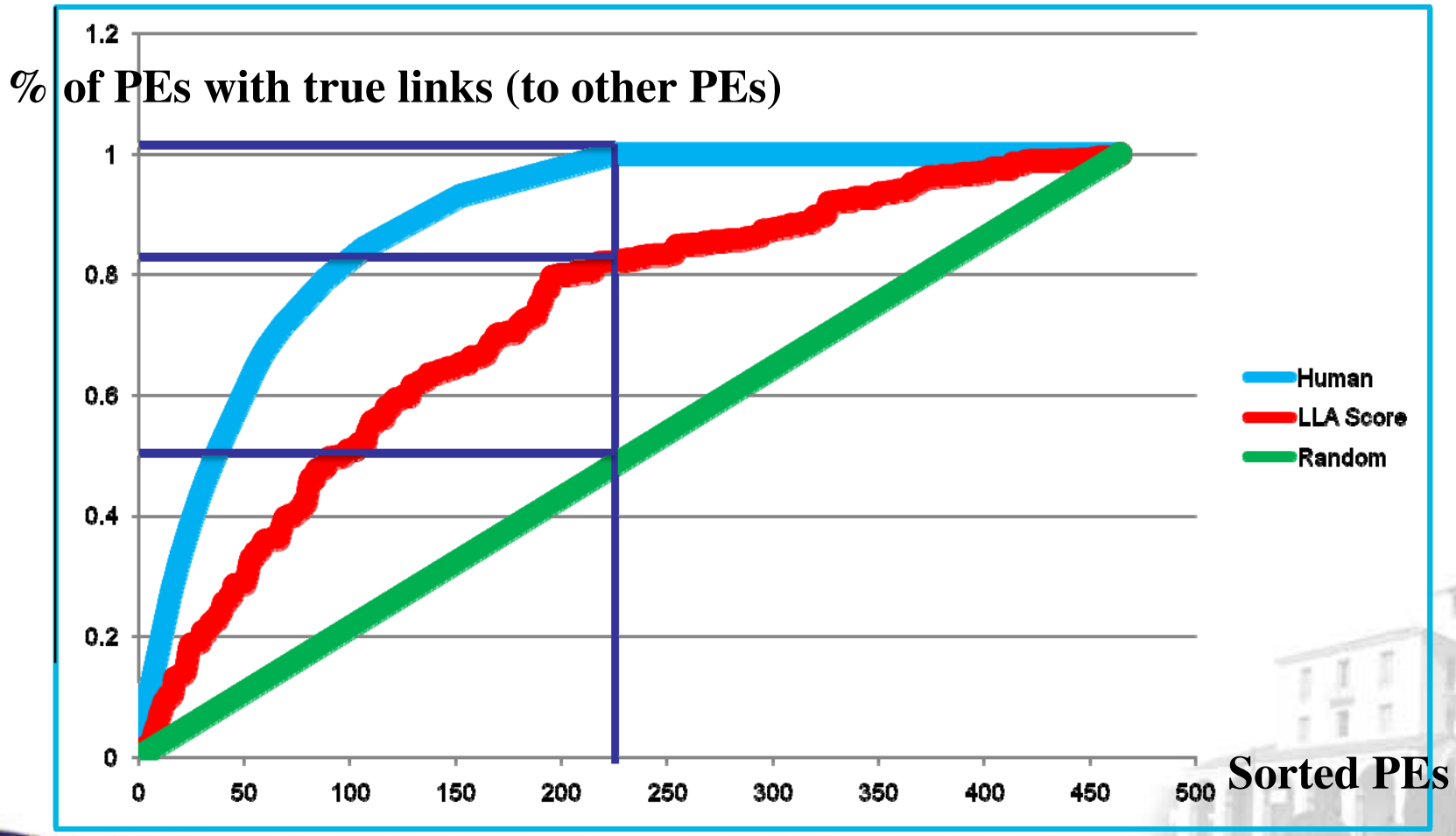
Pearson correlation between the two is 0.39 (p-value=0.0000001)

From human analysts

Visualize the Correlation



Use LLA Scores to Predict PE Links: Gains Chart



pe_pe.matrix.html - Microsoft Excel

	A	B	C
1		0101113F.txt	0101122F.txt
2	0604226F.txt	0027656.27;STERLING--VA;OWNERSHIP--COST,COSTS;BP16--INITIAL,PE	5.33
3	0101126F.txt	0019881.86;OWNERSHIP--COST,COSTS;BP16--INITIAL,PE	8.1
4	0207581F.txt	0018671.22;BP16--INITIAL,PE	5.72
5	0603235N.txt	0018667.64;SOURCED--DATA,SOFTWARE	3.16
6	0302015F.txt	0017172.55;OGDEN--AIR,AFB;REPLACES--CURRENT;DEPENDENT--SURVEILLANCE	6.87
7	0207136F.txt	0013337.67;AFMSS--UPGRADES,SS	6.79
8	0207417F.txt	0007315.54;RNP--GLOBAL,SURVEILLANCE;GWOT--FUNDING	6.69
9	0207249F.txt	0006227.37;ATP--EFFORT,REQUIREMENTS	7.9
10	0401119F.txt	0006133.00;OWNERSHIP--COST,COSTS;WARTIME--CAPABILITY,MISSIONS	7.14
11	0207590F.txt	0004917.94;LITENING--INTEGRATION,TARGETING	7.96
12	0204229N.txt	0004916.45;WARTIME--CAPABILITY,MISSIONS	4.91
13	0303601F.txt	0004548.71;FAB--INCREMENT[illegible]REMELY--FREQUENCY	7.79
14	0602271N.txt	0004227.58;EXTREMELY--FREQ[illegible]	3.22
15	0604503N.txt	0004227.12;EXTREMELY--FREQUENC	3.79
16	0401219F.txt	0003843.68;REPLACE	
17	0303109N.txt	0003807.47;EXTREME	
18	0901212F.txt	0003596.23;NORMAL	
19	0605709A.txt	0003592.63;NORMAL	
20	0602236N.txt	0002746.67;EXTREME	
21	0205633N.txt	0002698.57;OWNERS	
22	0604567N.txt	0002697.52;OWNERS	
23	0603635M.txt	0002697.32;OWNERS	
24	0204163N.txt	0002596.36;EXTREME	
25	0605976F.txt	0002396.59;GWOT--F	
26	0605805A.txt	0002288.60;OWNERS	
27	0305114F.txt	0002081.56;DEPENDI	
28	0604633A.txt	0002079.14;DEPENDI	
29	0401218F.txt	0001767.75;REPLACE	
30	0101127F.txt	0001538.71;EXTREME	
31	0603430F.txt	0001537.24;EXTREME	
32	0604240F.txt	0001536.97;EXTREME	
33	0303131F.txt	0001536.38;EXTREME	
34	0603432F.txt	0001536.18;EXTREME	
35	0603854F.txt	0001535.96;EXTREME	
36	0602235N.txt	0001535.65;EXTREME	
37	0605712F.txt	0001534.91;EXTREME	

Links discovered by LLA

Links noted by analysts

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Exhibit R-2, RDT&E Budget Item Justification: PB 2011 Air Force	**DATE:** February 2010
APPROPRIATION/BUDGET ACTIVITY 3600: *Research, Development, Test & Evaluation, Air Force* BA 7: *Operational Systems Development*	**R-1 ITEM NOMENCLATURE** PE 0101113F: *B-52 SQUADRONS*

The B-52 Extremely High Frequency (EHF) will integrate and install the B-52 fleet with assured and survivable two-way EHF SATCOM link for Emergency Action Messages (EAMs) and report-backs to meet Joint Chiefs of Staff (JCS) nuclear protected Information Exchange Requirements (IER). The B-52 EHF will integrate the Family of Advanced Beyond-Line-of-Sight (BLOS) Terminal (FAB-T) Increment 1 system developed and procured by Space and Missile Command (SMC) through PE 0303601F. The FAB-T system consists of the Operator Interface Group, Modem Processor Group, and Antenna Group. The B-52 EHF will integrate the following capability into the CONECT baseline B-52 architecture: a high data rate BLOS communication link supporting IP-based Global Information Grid (GIG) interoperability. The two Multi-function Color Displays (MFCDs) and the additional J-Series Messages that were to be integrated into CONECT with the B-52 EHF have been moved to the Strategic Radar Replacement and CONECT programs, respectfully. In addition, the automated reporting of aircraft fuel level status off-board the jet capability will also be moved from the B-52 EHF. Disposition of this capability is pending an approved acquisition strategy. The B-52 EHF program is planned to be accomplished in three increments. Increment 1 is the up front program planning and risk reduction trade studies on items like radome mounting, environmental cooling system (ECS) capabilities, antenna boresighting, etc. Increment 2 will integrate, and install the FAB-T equipment for strategic connectivity, as well as implement trade study solutions. In addition, the ECS will need to be upgraded or replaced. The ECS modification requirements will allow enough margin to accommodate near-term, future roadmap efforts. Finally, Increment 3 will provide GIG and net ready capability as well as full integration with other B-52 systems.

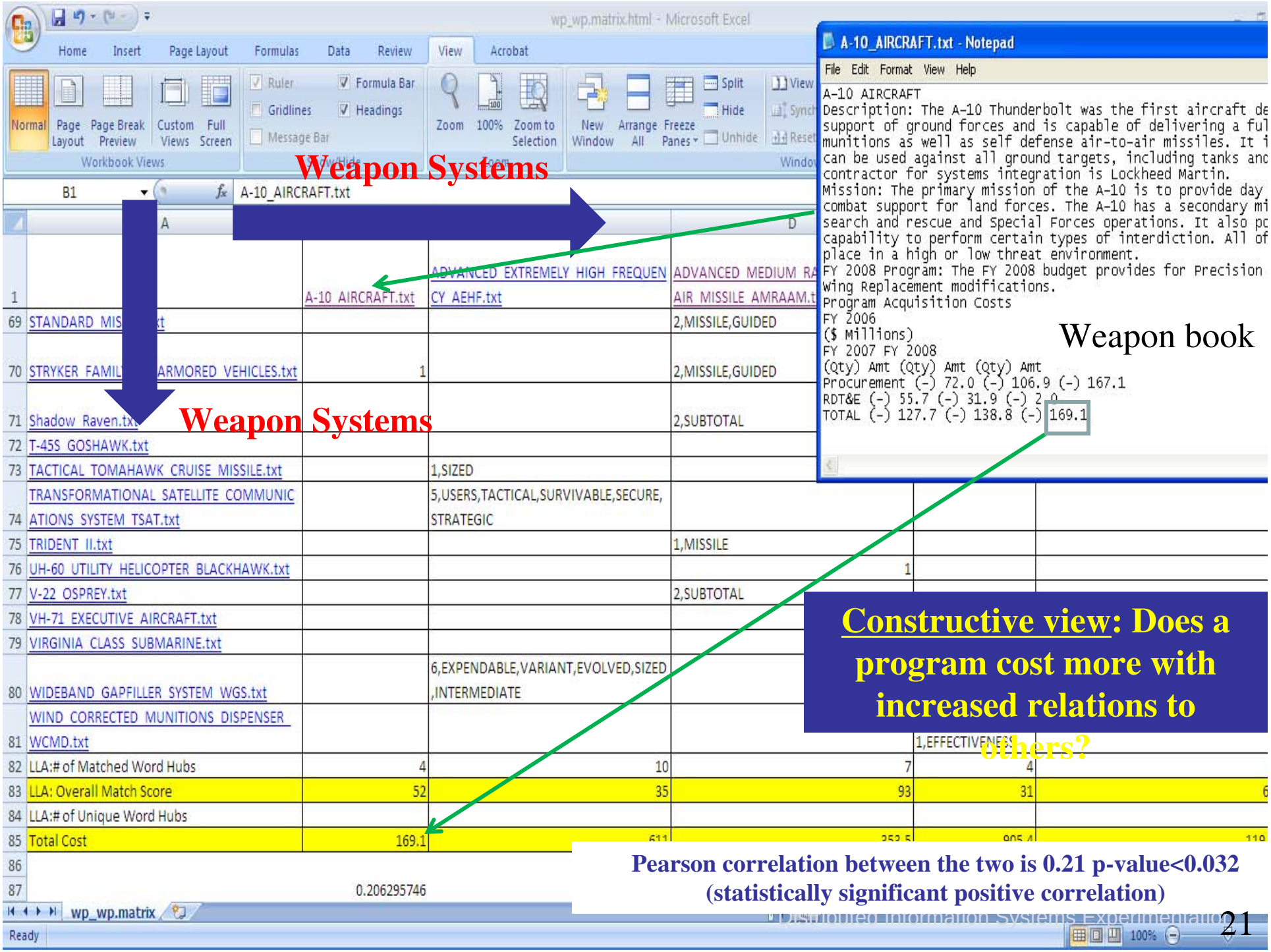
Trainers and upgrades for CONECT & EHF

In order to maintain currency with the latest aircraft configuration, the CONECT and EHF programs will update existing trainers or use computer-based training to add CONECT and EHF functionality to meet user-training requirements and establish a system integration laboratory (SIL) for updates of the Weapon System Trainers (WST).

Advanced Targeting Pod Functionality

The B-52 Modernization program fully integrates Advanced Targeting Pods (ATP) by linking pod control, display and target geo-location with the B-52 Offensive Avionics System (OAS). The B-52 ATP effort continues the ATP (Sniper or LITENING) integration effort that began in FY07 with GWOT funding. The ATP effort develops aircraft software updates to add and incorporate advanced pod functionality into the B-52. In addition, this effort upgrades the software functions of the new Alternate Mission Equipment (AME) (Multi Function Display and the Integrated Hand Controller), developed and procured under the B-52 Advanced Weapons Integration (AWI) modification, and enables the B-52 to utilize a LITENING or Sniper pod. This effort provides hardware and software upgrades to the existing aircrew/ maintenance trainers and the SIL.

Weapons Improvements


wp_wp.matrix.html - Microsoft Excel
Weapon Systems
A-10_AIRCRAFT.txt - Notepad
File Edit Format View Help
A-10 AIRCRAFT
Description: The A-10 Thunderbolt was the first aircraft de
support of ground forces and is capable of delivering a ful
munitions as well as self defense air-to-air missiles. It i
can be used against all ground targets, including tanks anc
contractor for systems integration is Lockheed Martin.
Mission: The primary mission of the A-10 is to provide day
combat support for land forces. The A-10 has a secondary mi
search and rescue and Special Forces operations. It also po
capability to perform certain types of interdiction. All of
place in a high or low threat environment.
FY 2008 Program: The FY 2008 budget provides for Precision
wing Replacement modifications.
Program Acquisition Costs
FY 2006
($ Millions)
FY 2007 FY 2008
(Qty) Amt (Qty) Amt (Qty) Amt
Procurement (-) 72.0 (-) 106.9 (-) 167.1
RDT&E (-) 55.7 (-) 31.9 (-) 2.0
TOTAL (-) 127.7 (-) 138.8 (-) 169.1
Weapon book
Weapon Systems
A-10_AIRCRAFT.txt
ADVANCED EXTREMELY HIGH FREQUENCY AEHF.txt
ADVANCED MEDIUM AIR MISSILE AMRAAM.t
STANDARD MIS xt
2,MISSILE,GUIDED
STRYKER FAMIL ARMORED VEHICLES.txt
2,MISSILE,GUIDED
Shadow Raven.tx
2,SUBTOTAL
T-45S GOSHAWK.txt
TACTICAL TOMAHAWK CRUISE MISSILE.txt
1,SIZED
TRANSFORMATIONAL SATELLITE COMMUNICATIONS SYSTEM TSAT.txt
5,USERS,TACTICAL,SURVIVABLE,SECURE,STRATEGIC
TRIDENT II.txt
1,MISSILE
UH-60 UTILITY HELICOPTER BLACKHAWK.txt
V-22 OSPREY.txt
2,SUBTOTAL
VH-71 EXECUTIVE AIRCRAFT.txt
VIRGINIA CLASS SUBMARINE.txt
WIDEBAND GAPFILLER SYSTEM WGS.txt
6,EXPENDABLE,VARIANT,EVOLVED,SIZED,INTERMEDIATE
WIND CORRECTED MUNITIONS DISPENSER WCMD.txt
1,EFFECTIVENESS
LLA:# of Matched Word Hubs
LLA: Overall Match Score
LLA:# of Unique Word Hubs
Total Cost
169.1
0.206295746
Constructive view: Does a program cost more with increased relations to others?
Pearson correlation between the two is 0.21 p-value<0.032
(statistically significant positive correlation)
wp_wp.matrix
Ready

There is a statistically insignificant correlation between weapon systems' RDT&E cost and # of lexical links to ACAT II systems

Weapon Systems

ACAT II Sys

	A	B	C	D	E	
1		A-10 AIRCRAFT.txt	EMELY HIGH FREQUEN CY AEHF.txt	ADVANCED MEDIUM RANGE AIR-TO-AIR MISSILE AMRAAM.txt	AH-64 APACHE.txt	AIR I
11	Unit Water Pod Sy (Camel).pdf	0.04	0.11,VEHICLE,TACTICAL	0.11,MEDIUM	0.05,INTEGRATED	
12	Warfighter Inform Network-Tactical (WIN-T).p	0.22,ENVIRONMENT,COMBAT,INTEGRATION,LOCKHEED	0.37,INTEGRATION,SECURE,COMMUNICATIONS,WARFIGHTER,DATA,TACTICAL,LOCKHEED	0.13,ENVIRONMENT,JOINT	0.16,INTEGRATED,SUPPORTS	0.14,E
13	Wire-Guided (TOW) Missiles.pdf	0.20,PRECISION,VEHICLES,RANGE,MISSILES,THREAT	0.16,LAUNCH,PRIME,VEHICLE,ADVANCED,CONTROL,ANTI	0.24,PRIME,GUIDED,MISSILE,AZ,ADVANCED,RANGE,RAYTHEON	0.18,PRIME,MISSILE,AZ,MOUNTED,CONTROL	0.37,L NGE,R
14	XM101 Common Remotely Operated Weapon Station.pdf	0.20,ARMORED,TARGETS,VEHICLES,RANGE	0.03,VEHICLE	0.07,TARGETS,RANGE	0.13,SENSORS	0.07,T
15	XM307.pdf	0.19,ARMORED,TARGETS,COMBAT,INTEGRATION,VEHICLES	0.19,LAUNCH,PRIME,VEHICLE,INTEGRATION,ADVANCED,VARIANT	0.17,TARGETS,PRIME,ADVANCED,RAYTHEON	0.14,PRIME,MOUNTED	0.19,L AYTHE
16	LLA:# of Matched Word Hubs	24	27	19	25	
17	LLA: Overall Match Score	21.76839827	21.52527465	17.7039979	17.48533462	
18	LLA:# of Unique Word Hubs	8				
19	PE Forward Links					
20	PE Backward Links					
21	PE Links(Forward+Backward)	0				
22	RDT&E Cost	2	603.2	41.4	193.7	
23						
24	Pearson correlation	0.181598022				

Pearson correlation between the two is 0.18
p-value<0.055 statistically insignificant

Correlation between Unique # of LLA Word Hubs and Increasing Procurement Cost

Weapon Systems

ACAT II Sys

	A	C	D	E	
1		A-10 AIRCRAFT.txt	ADVANCED EXTREMELY HIGH FREQUENCY AEHF.txt	ADVANCED MEDIUM RANGE AIR-TO-AIR MISSILE AMRAAM.txt	AH-64 APACHE.txt	AIR IN
111	Unit Water Pod S (Camel).pdf	0.04	0.11,VEHICLE,TACTICAL	0.11,MEDIUM	0.05,INTEGRATED	
112	Warfighter Infor Network-Tactical (WIN-T)	0.22,ENVIRONMENT,COMBAT,INTEGRATION,LOCKHEED	0.37,INTEGRATION,SECURE,COMMUNICATIONS,WARFIGHTER,DATA,TACTICAL,LOCKHEED	0.13,ENVIRONMENT,JOINT	0.16,INTEGRATED,SUPPORTS	0.14,E
113	Wire-Guided (TOW) Missiles.pdf	0.20,PRECISION,VEHICLES,RANGE,MISSILES,THREAT	0.16,LAUNCH,PRIME,VEHICLE,ADVANCED,CONTROL,ANTI	0.24,PRIME,GUIDED,MISSILE,AZ,ADVANCED,RANGE,RAYTHEON	0.18,PRIME,MISSILE,AZ,MOUNTED,CONTROL	0.37,L NGE,R
114	XM101 Common Remotely Operated Weapon Station.pdf	0.20,ARMORED,TARGETS,VEHICLES,RANGE	0.03,VEHICLE	0.07,TARGETS,RANGE	0.13,SENSORS	0.07,T
115	XM307.pdf	0.19,ARMORED,TARGETS,COMBAT,INTEGRATION,VEHICLES	0.19,LAUNCH,PRIME,VEHICLE,INTEGRATION,ADVANCED,VARIANT	0.17,TARGETS,PRIME,ADVANCED,RAYTHEON	0.14,PRIME,MOUNTED	0.19,L AYTHE
116	LLA:# of Matched Word Hubs	24	27	19	25	
117	LLA: Overall Match Score	21.76839827	21.52527465	17.7039979	17.48533462	
118	LLA:# of Unique Word Hubs	8	14	7	8	
119	PE Forward Links					
120	PE Backward Links					
121	PE Links(Forward+Backward)	0	0	0	0	
122	**Procurement Cost**	**167.1**	**7.8**	**312.1**	**711.7**	

Pearson correlation between the two is 0.34

p-value < 0.001 statistically significant

Results/Conclusions

- Provided an automated tool to surface important aspects among programs
- Proved LLA Validity for automation
  - Adequately models expected human performance but faster
- Demonstrated correlation among relations between programs
  - Cost drivers: Interrelated and Uniqueness
- Discovered statistically significant correlations of Lexical links between MDAP and ACAII, and RDT&E cost

Future Work

- Extract lexical links for applications
  - Continue to explore available acquisition data
    - Extract the cost of MDAP programs (PNO) from the PE documents
    - Compare with SAR (Selected Acquisition Report) as in the MDAP perspective
  - Search for other correlations among other program attributes
  - Identify more dependent variables
    - Diversity metrics
  - Predict program costs using this methodology
    - Cost and cost growth relative to the Milestone B
    - Cascade effect of program costs

Future Work

- Determine methods to leverage the NPS HPC to analyze larger data sets
- Develop improved graphic illustrations of findings
  - 3-D
  - Dynamic
- Provide an automatic LLA service for program self-awareness
  - Enterprise Lexicon Service
  - Meta-Data Registry
- Establish a complex system theory for a cross-domain
  - Law of requisite variety
  - Design Structure Matrix

Program-Awareness via Lexical Link Analysis (LLA)

Dr. Ying Zhao, Dr. Shelley P. Gallup, Dr. Douglas J. MacKinnon

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