Productivity Data Analysis and Issues

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Ground System Architectures Workshop

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This work is sponsored by the Air Force Cost Analysis Agency

Objective

- Improved cost estimation of future DoD software-intensive systems, as well as to the DoD cost community.
  - Characterize different application domains within DoD
  - Analyze collected data for simple cost estimating relationships within each domain
  - Develop rules-of-thumb for missing data
- Make collected data useful to oversight and management entities

SRDR Data

	Operating Environment						
Application Domain	**Avionics**	**Fixed Ground**	**Missile**	**Mobile Ground**	**Shipboard**	**Unmanned Space**	**Total**
Business Systems				4			4
Command & Control	1	8		5			14
Communications	1	35			2	1	39
Controls & Displays	2	1		1	3		7
Executive					3		3
Information Assurance		1					1
Infrastructure or Middleware		2			1		3
Mission Management	12	2	3	1			18
Mission Planning	1	4					5
Process Control				4			4
Scientific Systems					3		3
Sensor Control and Processing		2			10		12
Simulation & Modeling		9			3		12
Spacecraft Payload						1	1
Test & Evaluation		1					1
Tool & Tool Systems		3					3
Training				1			1
Weapons Delivery and Control	4		7				11
Total	21	68	10	16	25	2	142

Notes:
SRDR: Software Resources Data Report

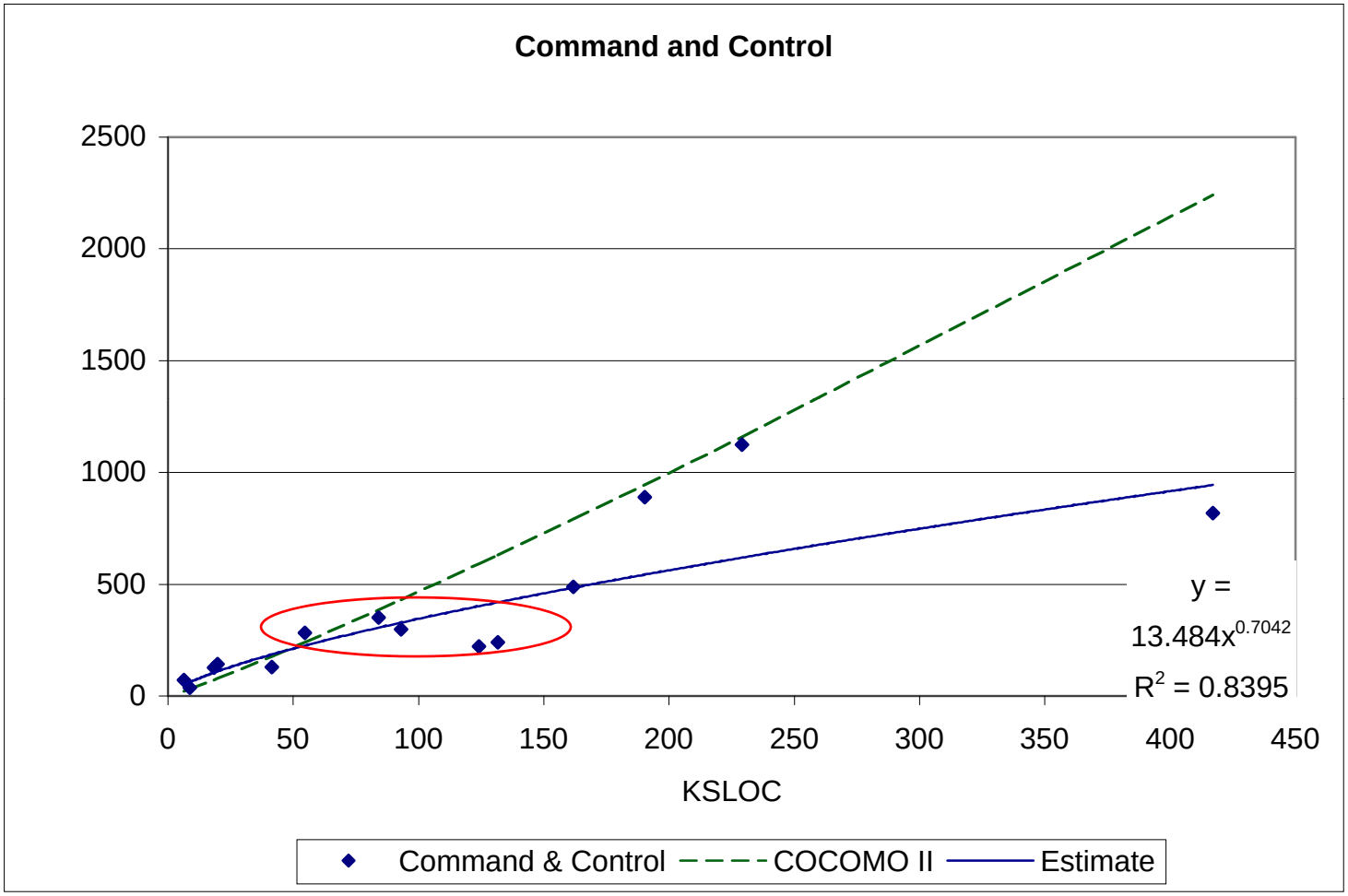
Simple Cost Estimating Relationships

$$PM = A * (EKSLOC)^{B}$$

Domain Name	Data #	Estimation Formula	R-Square
Command & Control	14	Y = 13.48 * X ^ 0.70	0.84
Communications	39	Y = 19.58 * X ^ 0.59	0.62
Control & Displays	7	Y = 53.84 * X ^ 0.44	0.70
Mission Management	18	Y = 17.62 * X ^ 0.79	0.58
Mission Planning	5	Y = 33.03 * X ^ 0.42	0.64
Sensor Control & Processing	12	Y = 144.74 * X ^ 0.27	0.15
Simulation	12	Y = 68.97 * X ^ 0.26	0.21
Weapons Delivery & Control	11	Y = 9.42 * X ^ 0.84	0.73

Preliminary Results - Do Not Use!

Notes:
PM: Person Months (152 labor hours / month)
EKSLOC: Equivalent Thousands of Source Lines of Code



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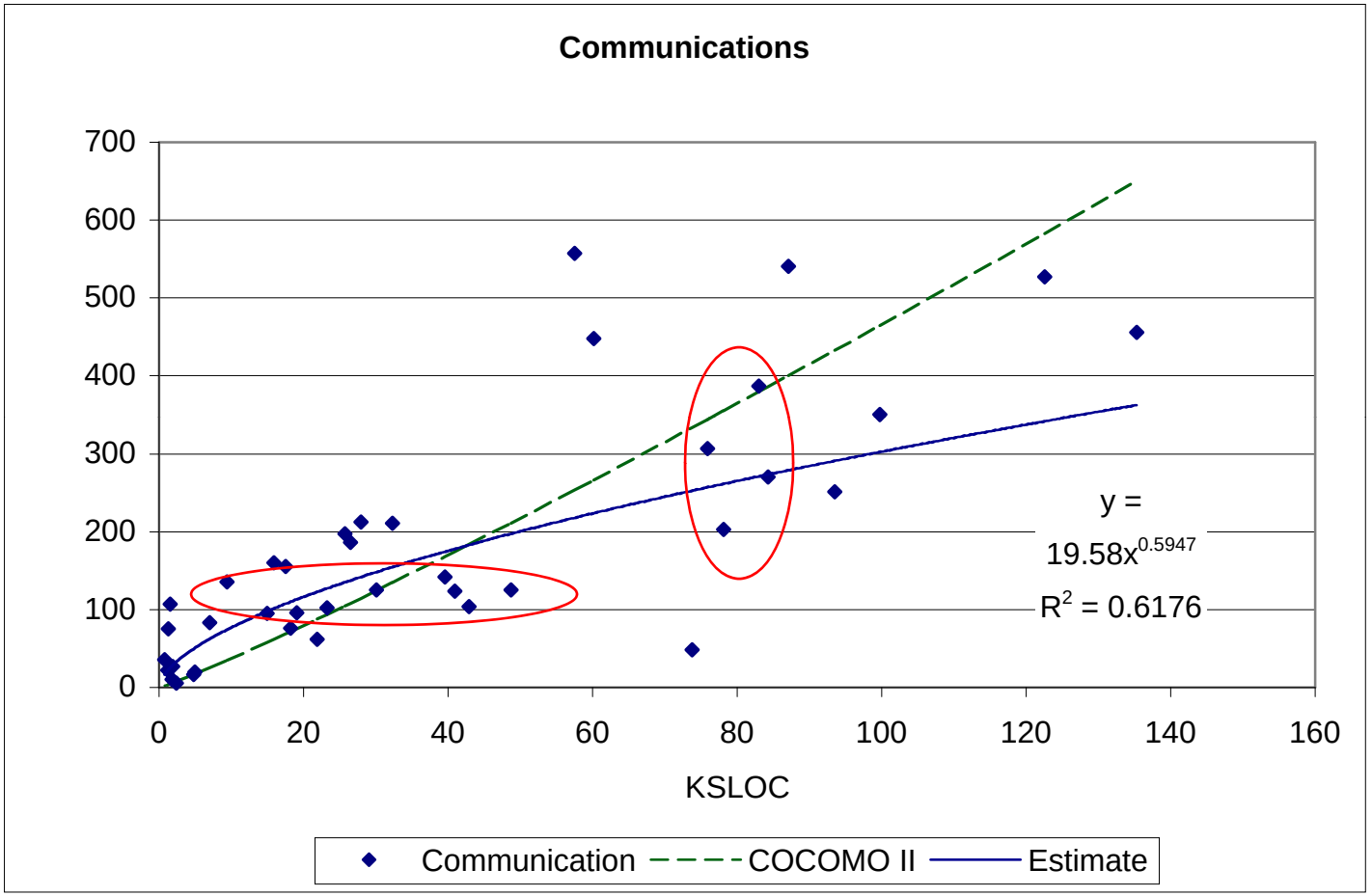

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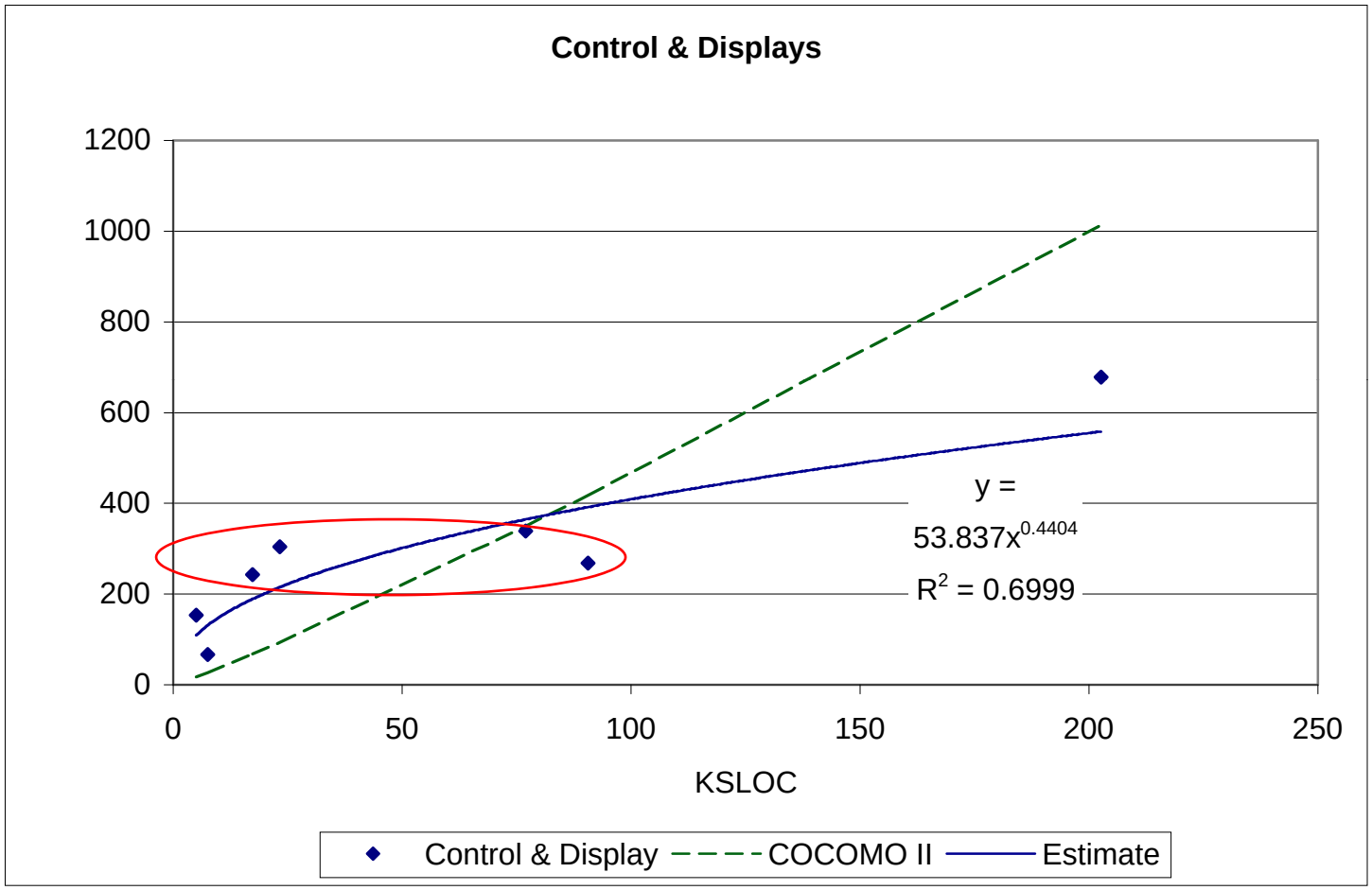

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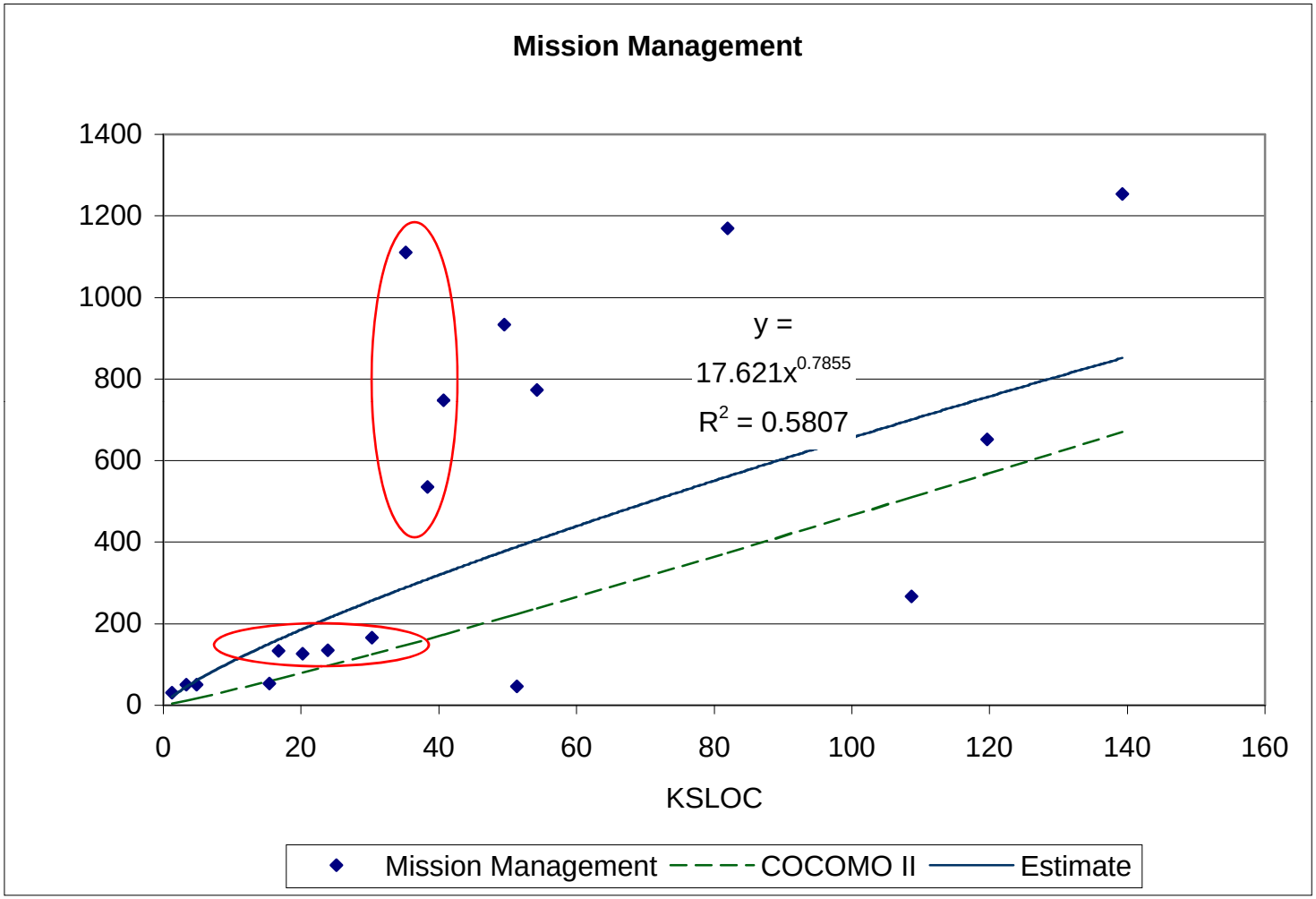

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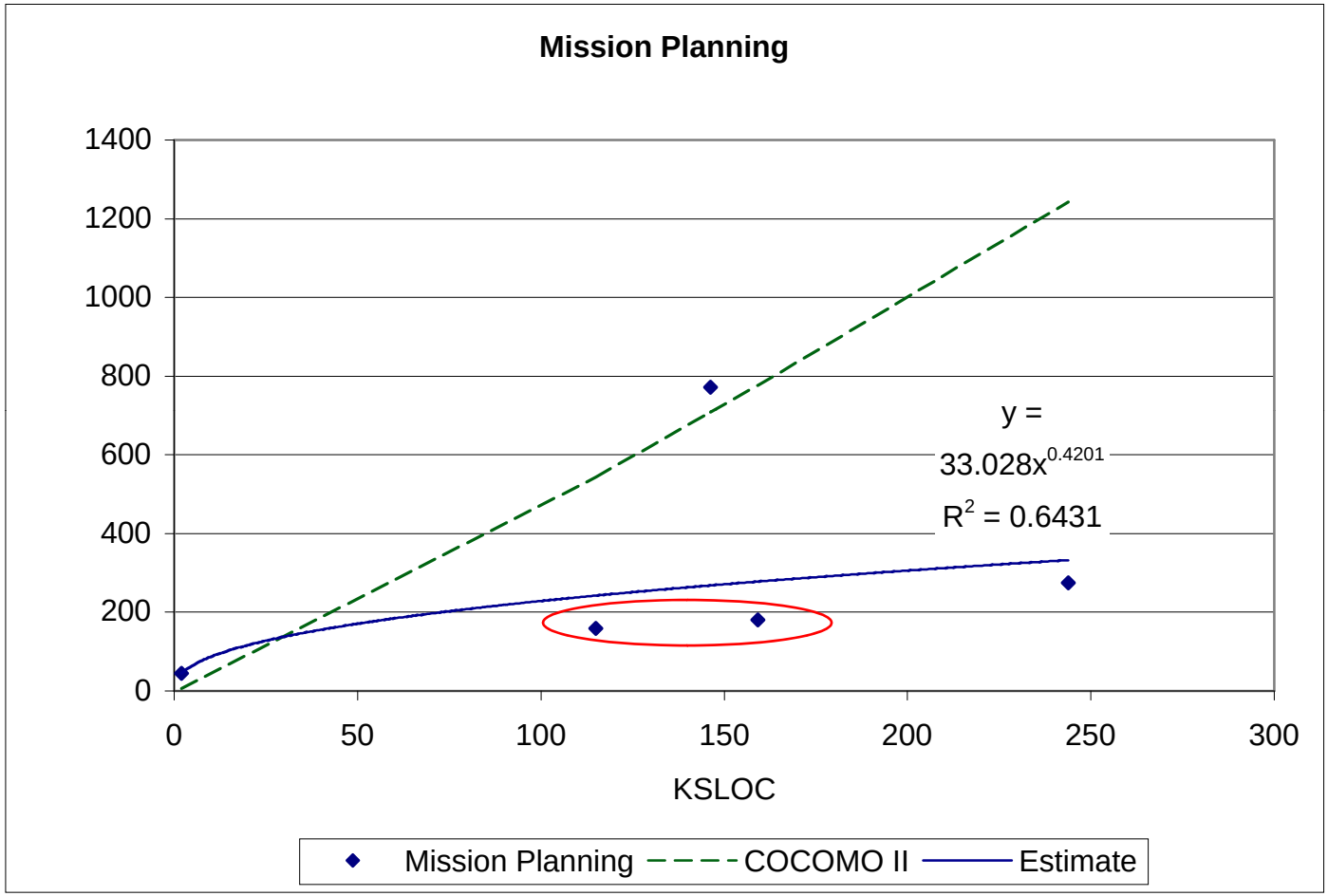

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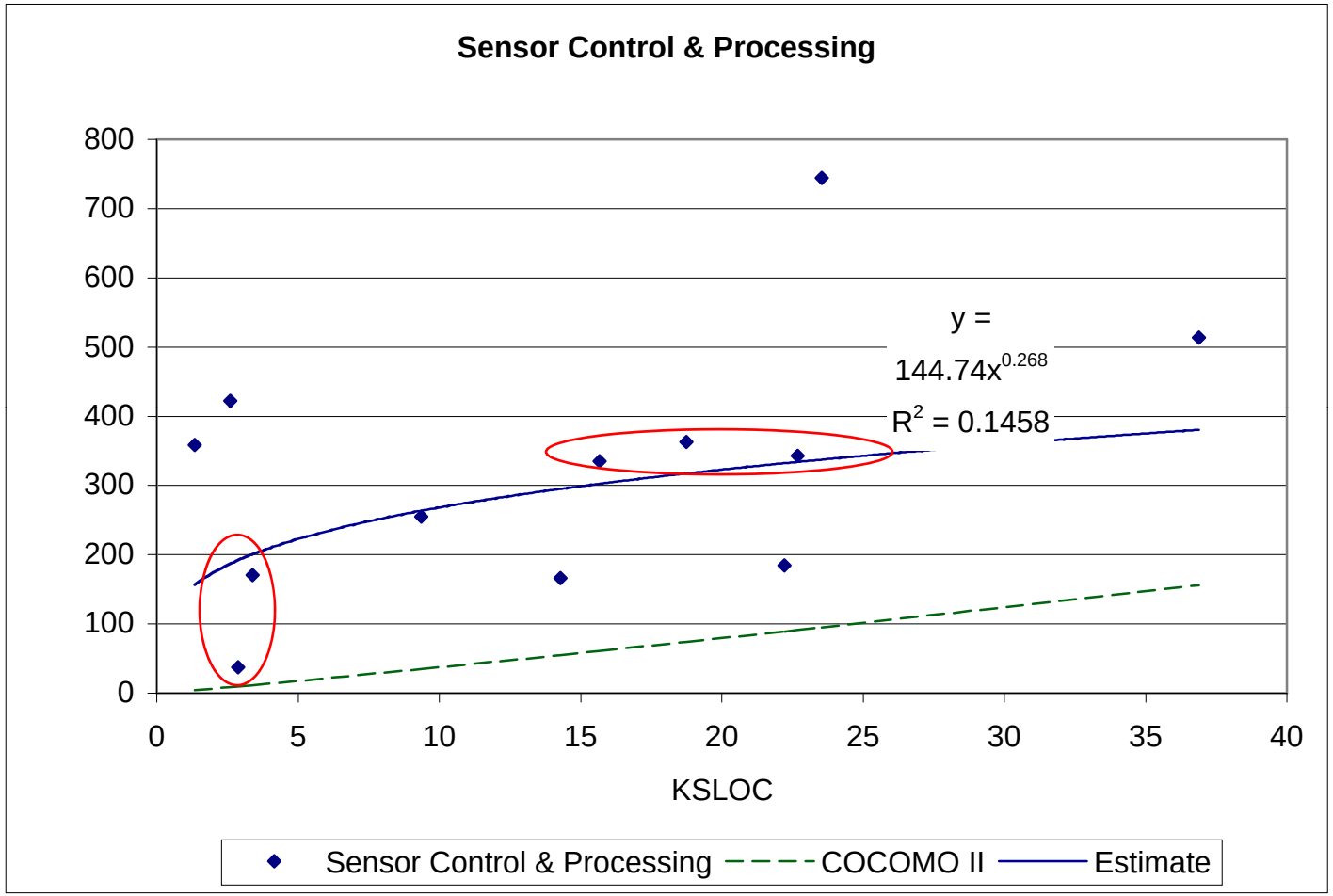

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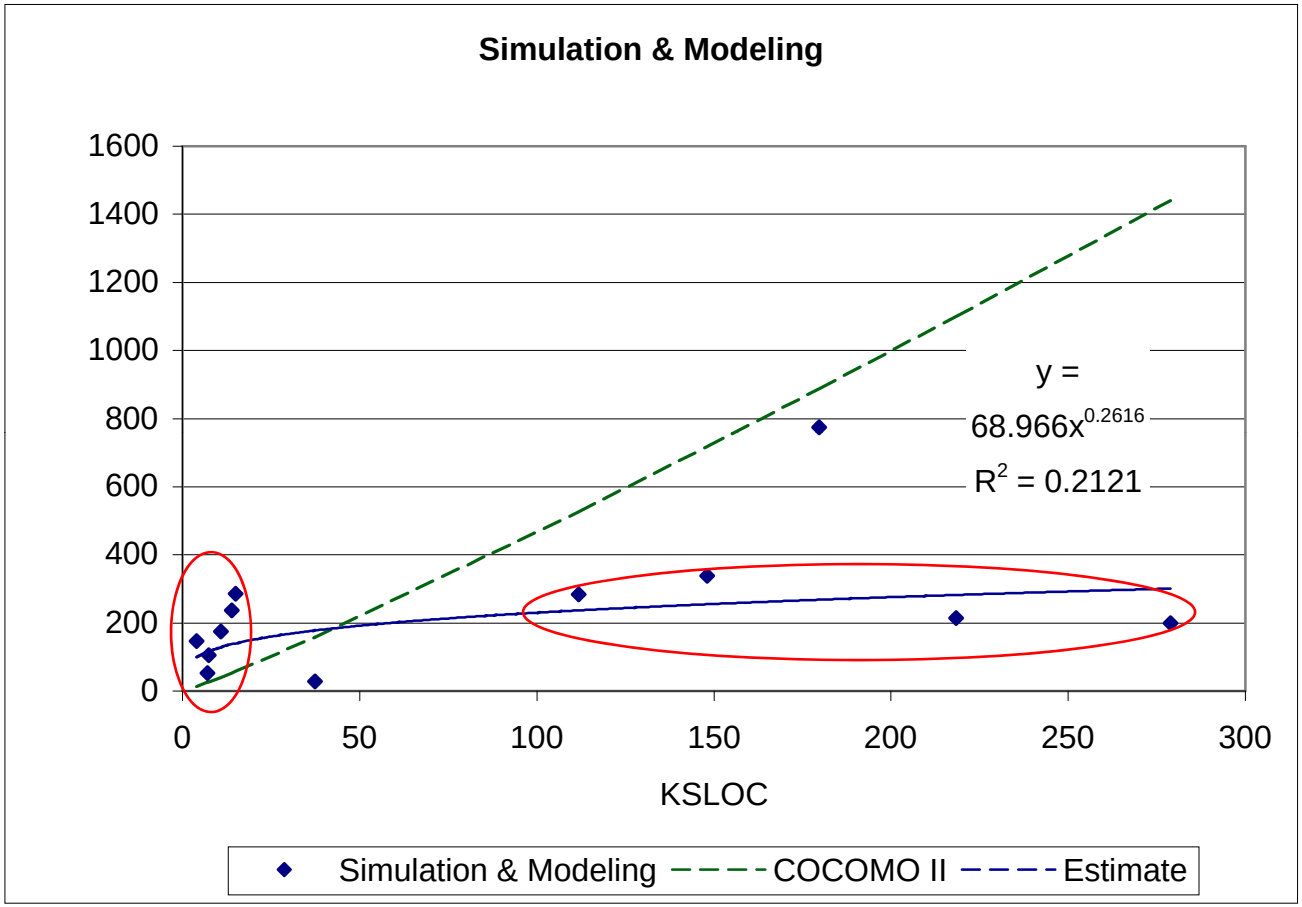

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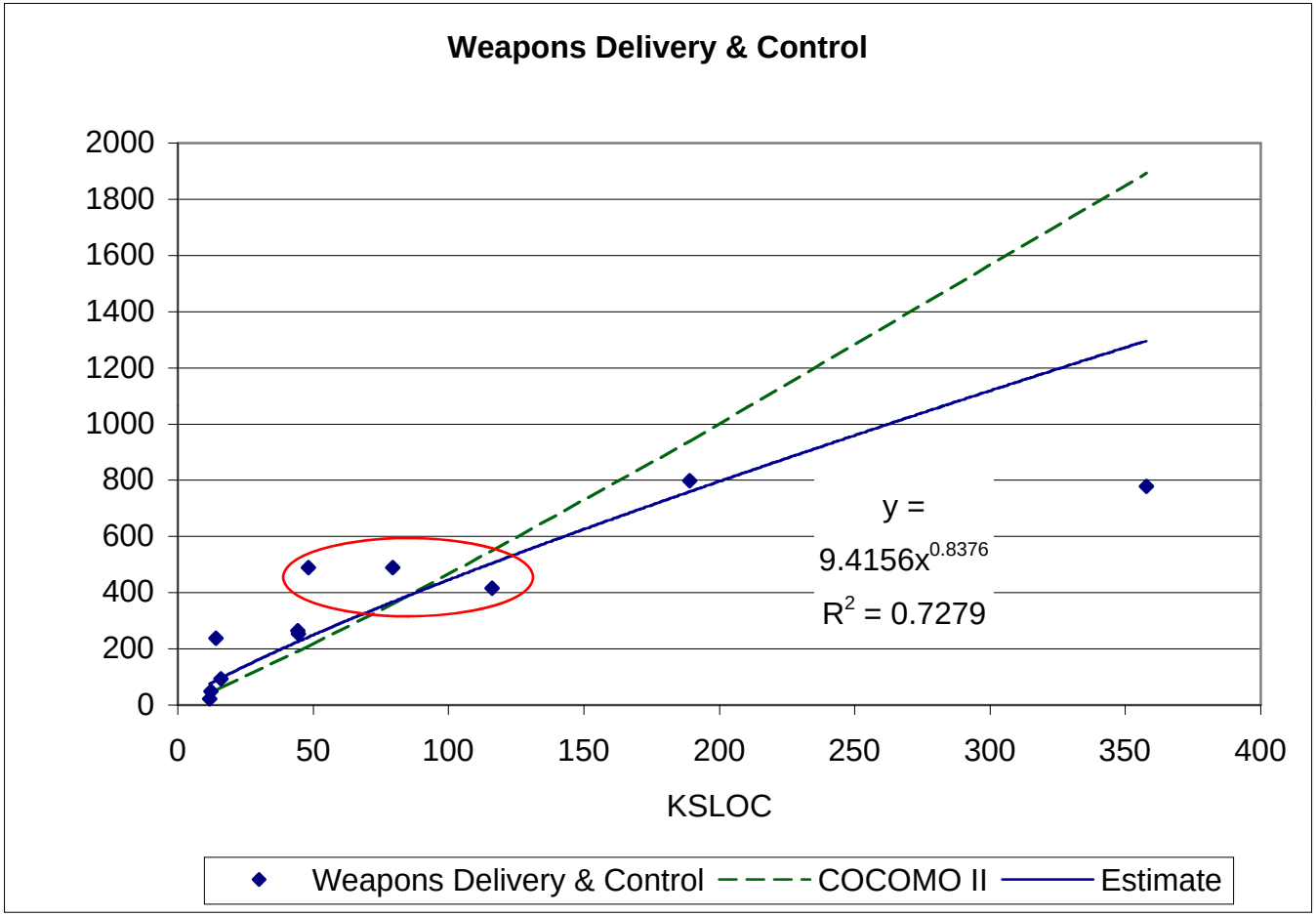


Preliminary Results - Do Not Use!

Productivity Analysis Issues

- Why do some data have the same amount of effort for widely varying size?
- Why do some data have similar sizes for widely varying effort?
- Will the information that explains the differences be available early in the lifecycle?
- Are there too many Application Domains (18) and Environments (6)?

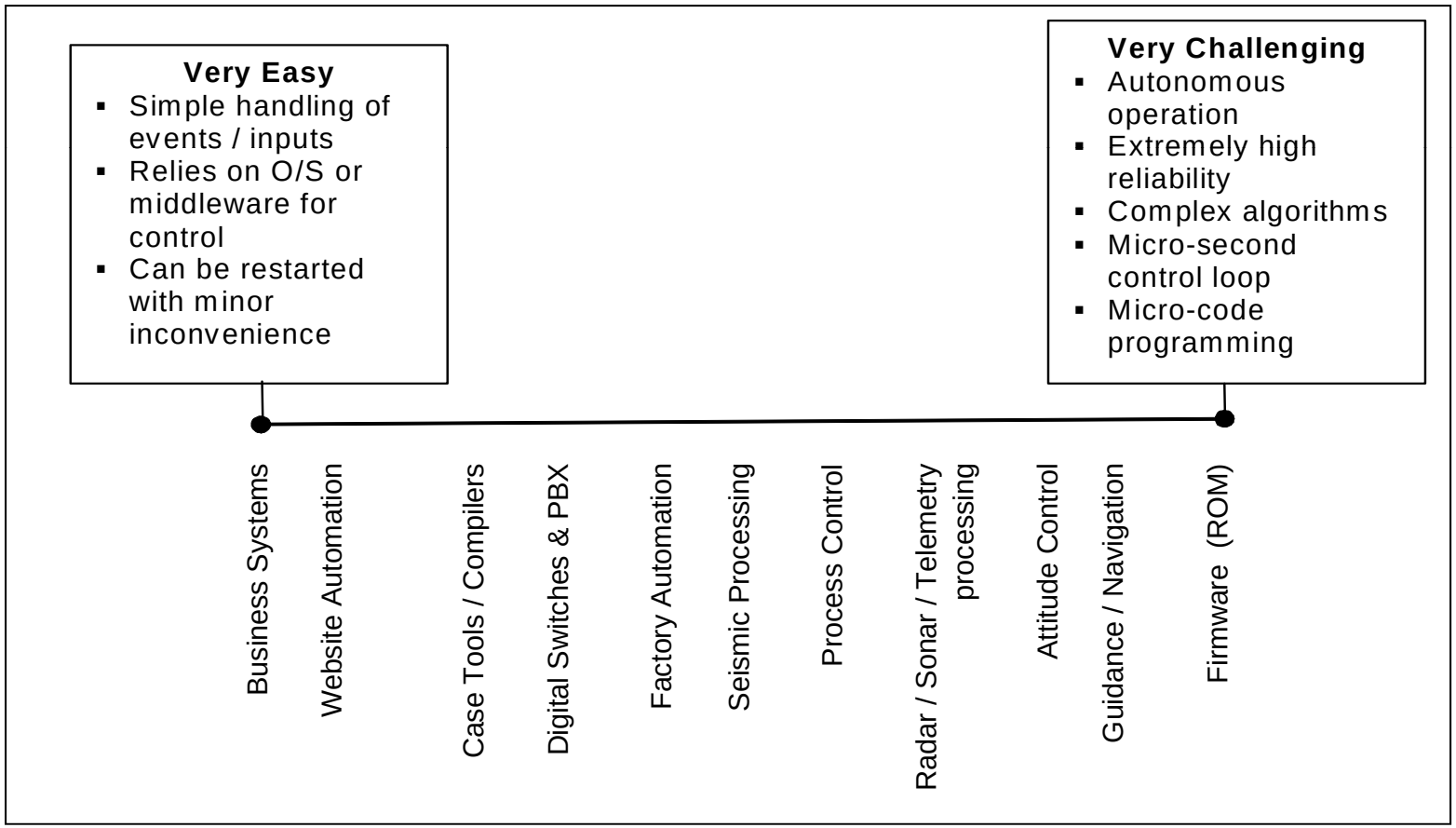
Collapsing Application Domains

- Propose to reduce the number of application domains
- Use a model-independent approach
  - 5-level scale to capture the “difficulty” (and therefore impact) of an application domain on productivity

- This presentation discusses this new approach
- As a work-in-progress, we welcome comments and suggestions
- Please join us at this workshop to discuss this approach and its usage

Software Application Difficulties

Difficulty would be described in terms of required software reliability, database size, product complexity, integration complexity, information assurance, real-time requirements, different levels of developmental risks, etc.



Software Application Difficulties

- Very Easy
  - Risks are well understood with little loss from failure
  - Business or operational logic is straightforward
  - Limited interface to other software applications
  - Mostly stand-alone functionality
  - Simple tests
- Easy
  - Not a new type of application
  - Risks are understood and mitigation strategies exists
  - Business or operational logic is straightforward
  - Requires low reliability due to small or little loss when unavailable
  - Limited external interface and security requirements
- Nominal
  - Somewhat complicated business logic
  - Risks exists and may need additional study to find mitigation
  - May require distributed environment with additional security requirements
  - Moderate, easily recoverable loss for nominal reliability
  - Not a new type of application

Software Application Difficulties

- Challenging
  - High reliability due to greater impact of loss or high probability of risk
  - Risks are challenging to resolve
  - Very complicated business logic, external storage may be necessary due to distributed environment
  - New type of application
  - Hard real-time control and security requirements
  - Additional communication interfaces necessary for external components or systems
- Very Challenging
  - Extremely complicated business logic
  - Risks are very challenging to resolve and loss is great (disastrous consequences)
  - Many automated controls with limited human control
  - New type of application
  - Hard real-time control and security requirements
  - Communication to external components through different interfaces

Application Difficulty

Application Domains	Very Easy	Easy	Nominal	Challenging	Very Challenging
Business Systems		Large biz system			Trillion $/day transaction
Internet	Simple web pages	Web application (shopping)		Mega-web application	
Tools and Tool Systems			Verification tools	Safety critical	
Scientific Systems		Offline data reduction		Large dataset	
Simulation and Modeling		Low fidelity simulator		Physical phenomenon	
Test and Evaluation		Usual		Distributed debugging	
Training	Set of screens			Simulation network	
Command and Control		Taxi-cab dispatch			SOS (C4ISR)
Mission Management				Usual	Multi-level security and safety
Weapon Delivery and Control				Weapon space	Safety
Communications				Noise, anomalies handling	Radio Safety/Security Frequency-hopping

Application Difficulty

Application Domains	Very Easy	Easy	Nominal	Challenging	Very Challenging
Control and Displays	GUI builders			Voice and image recognition	Advance human prosthetics
Infrastructure or Middleware		TCP/IP		SOS (SOSCOE)	
Executive				EAF level 4+	Security certification (EAF Level 7)
Information Assurance					
Maintenance and Diagnostics	Fault detection			Fault isolation and prognostics	
Mission Planning			Usual		
Process Control			Usual		
Sensor Control and Processing			Usual	Data fusion	
Spacecraft Bus				Usual	
Spacecraft Payload					(F6)

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Questions?