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Functional Measure of a Real-time System

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Agenda

- Introduction
- Case Study
 - Description of the Project
 - Data Collection
 - Measurement results
- Sensitivity Analysis
- Conclusion

Introduction

Functional Size

- Functionality based size measure of software
- ISO definition: a size of the software derived by quantifying the Functional User Requirements
- Independent of the development methodology, programming language and capability of the project team
- Provides an objective, comparative measure

Introduction

Functional Size Measurement Methods

- First publication in 1979 by Alan Albrecht
- Many variations, extensions of the original one available
- Current promoter of Albrecht's FPA is IFPUG
 - Most commonly used FSM Method
- FFP method was introduced in 1996
- COSMIC FFP method was introduced in 1999
- In 1996, ISO started a working group on FSM to establish common principles of those methods.

Case Study

Methods applied & Objectives

Methods applied:

- IFPUG FPA
- COSMIC-FFP

Objective:

- To measure a real-time system through a case study using two most significant FSM methodologies, which are COSMIC and IFPUG FPA,
 - looking in detail to the measurement processes and obtained results,
 - to compare the findings

Case Study

Description of the case project(1/3)

The case project was:

- an industry control system, named Automatic Production Environment (APE) system
 - simulates the ability of a real-time software based system to transfer a luggage item down a conveyer belt and scan it
 - the artifact of a graduate level software engineering course (Specification and Design of Real-time Systems) at Embry-Riddle Aeronautical University
 - implemented in Fall 2007 semester

Case Study

Description of the case project (3/3) *(too much detail)*

- Available project documents
 - Project Summary
 - Software Development Plan
 - Software Requirements Specification (including UML diagrams)
 - Requirements Inspection Report
 - Software Design Document
 - Design Inspection Report
 - Source Code Documentation and Analysis
 - Test Plan
 - System User Manual
 - Presentation
 - Short Video Demonstration
- Both size measurements presented in the following section are conducted using Software Requirements Specification (SRS) document of the project

Case Study

Data Collection (1/2)

- The case study was conducted in December 2008 in the scope of SM 517 Software **Measurement** course given by Dr.Desharnais in METU, Informatics Institute (you should precise verbally Ankara, Turkey)
- Four people performed the size measurement;
 - one of them is IFPUG certified two times
 - three of them are COSMIC certified at the 'Entry Level'
 - one of them is a co-author of the COSMIC method
- Measurement results kept in word docs, not on any tool
- Two methods applied sequentially
 - Effort utilized for COSMIC-FFP measurement:
 - 16 person-hours
 - Effort utilized for IFPUG FPA measurement:
 - 8 person-hours

Case Study

Data Collection (2/2)

- Within the scope of this study, only unadjusted IFPUG FPA is considered since it reflects the specific functions provided to the users by the project or application. Furthermore, the adjusted portion of FPA is not recognized by ISO (underline not necessary)
- Software Requirements Specification (SRS) document of the case project, which involves 6 Use Cases (UC), was used for measurement.
 - developed according to IEEE Std. 830-1998, “IEEE Recommended Practice for Software Requirements Specifications”, includes entity-relationship diagram, data dictionary, use case diagram, sequence diagrams, state charts, data flow diagrams, use case descriptions are (not necessary)
 - the use cases, FURs, of the SRS usually correspond to the logical transactions in COSMIC-FFP

Case Study

Measurement Results (1/5)

IFPUG FPA Data Functions

ILF	# of DETs	# of RETs	Complexity	Unadjusted FP Count
DF1	1	-	Low	7
DF2	1	-	Low	7
DF3	1	-	Low	7
DF4	1	-	Low	7
DF5	1	-	Low	7
EIF		-		
DF6	8	-	Low	5
TOTAL				40 FP

Case Study

Measurement Results – Size (2/5)

IFPUG FPA Transactional Functions

Transactional Function	Transaction Type	# of DETs	# of FTRs	Complexity	Unadjusted FP Count
A0	NA	NA	NA	NA	NA
A1	EI	10	1	Low	3
A2	EO	3	3	Low	4
A3	EO	4	1	Low	4
A4	EI	5	4	Average	4
TOTAL					15

Case Study

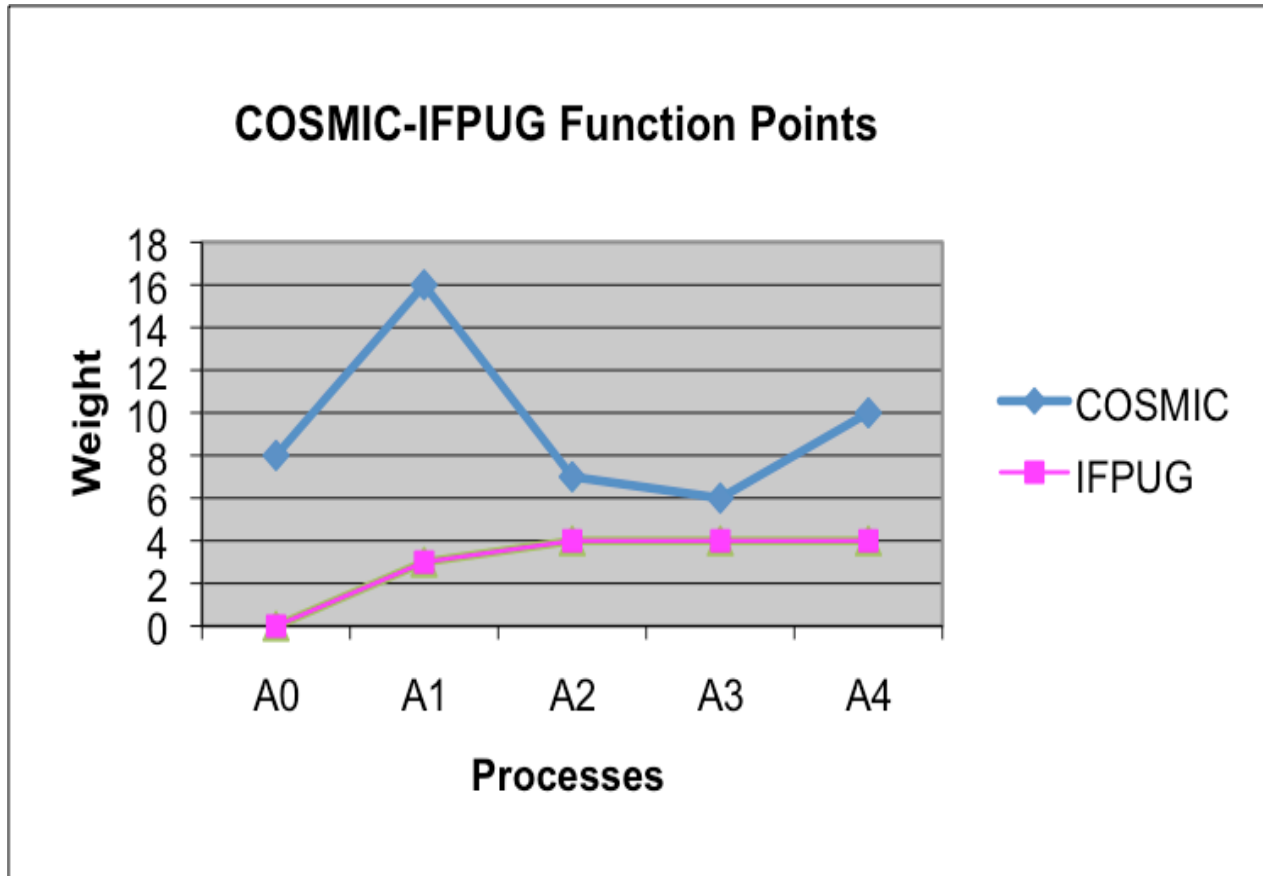
Measurement Results – Size (3/5)

COSMIC Functional Processes

Functional Processes	Entries	Exits	Reads	Writes	Functional Size (CFP)
A0	3	5	-	-	8
A1	7	8	-	1	16
A2	2	2	2	1	7
A3	2	3	-	1	6
A4	4	2	-	4	10
TOTAL					47

Case Study

Measurement Results – Size (4/5)



Case Study

Measurement Results – Size (5/5)

Total Measurement Results

	IFPUG FPA – Function Points (FP)	COSMIC- Function Points (CFP)
Data Functions	40	NA
Transactional Functions (Functional Processes)	15	47
TOTAL	55	47

Sensitivity Analysis

Data Functions

- IFPUG FPA data size is over represented (1 DET gives 7 points)
- The size of the transactions is 'flattened' due to the maximum points per transaction

Sensitivity Analysis

Functional Processes(Transactional Functions) (1/3)

- **In other words:**
 - Total size of all transactional functions with IFPUG is 15 points only because the IFPUG FPA tables assigns a maximum of 4 points when having one DET.
 - COSMIC size is much greater for each functional process, from 6 to 16 since COSMIC does not have an arbitrary upper limit on the size of a functional process.

Sensitivity Analysis

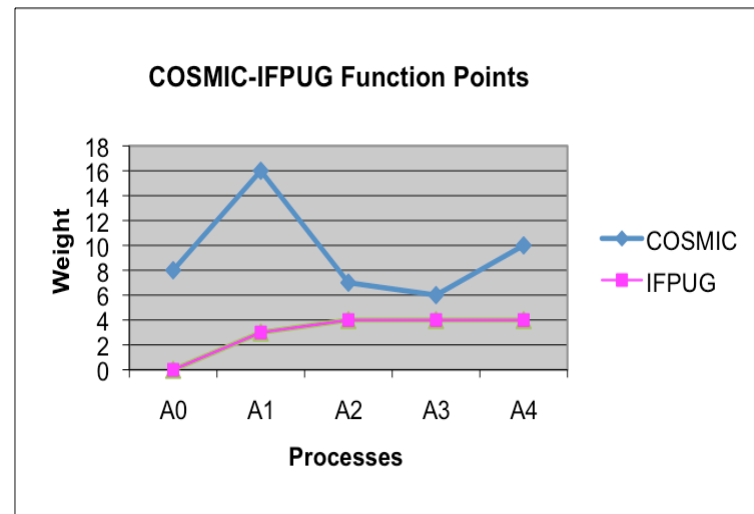
Functional Processes(Transactional Functions) (2/3)

- One functional transaction was excluded from IFPUG FPA method because there was no persistent data group for function.
- COSMIC rules consider both persistent Read and Write and non-persistent Entry and eXit data group. A Functional process without a Read or a Write (of persistent data group) can be measured with COSMIC while it cannot with IFPUG FPA.
- If a persistent data group were to be added later to this functional process, this would add only a single size unit in COSMIC, while 4 FP would be added at once with IFPUG FPA which is more sensitive to this type of error:
 - IFPUG FPA approach is a step-wise framework of intervals and weights, which leads to size steps for the transactional functions of 3, 5 and 6 points.

Sensitivity Analysis

Functional Processes(Transactional Functions) (3/3)

- Across real-time functional processes with potentially significant variations of data movements, the IFPUG FPA measurement results are within one to two points of each other while the variation of the number of data movements can be much larger, and this large variation should lead to larger increases in the size of a functional process.



Sensitivity Analysis

General

- While the difference between the two sizes at the total level is less than 20% (47 CFU by COSMIC and 55 FP by IFPUG FPA), the difference at the lower level is much larger.
 - While COSMIC size is the result of the direct size of the functional process size, the IFPUG FPA size is the result of the measurement of both the data groups and the transactions.
 - Therefore, at the level of the transactional size, the difference is greater than 70%.

Sensitivity Analysis

Comments (1/3)

- COSMIC allows for a finer granularity and is not burdened by large step-functions
- IFPUG FPA is much less able to discriminate the size of very small functional processes and, is much less able to assign large sizes to large and very large functional processes
- IFPUG FPA significantly over-represents the size of the 'data functionality' when the data groups are very small (with 1 attribute for example)

Sensitivity Analysis

Comments (3/3)

- COSMIC would therefore provide a 'better' quantitative functional size with much more quantitative discriminative measurement power
- When comparisons are made across methods to evaluate the adequacy of the measurement method for sizing real-time software the COSMIC method should be used as the reference point since it is more sensitive at the detailed level

Conclusions

- COSMIC-FFP captures the functionality directly at the process level
 - by producing quantitative results that capture with better sensitivity the size of very small functional processes to very large processes
 - while being able to represent with better sensitivity the 'functional size' differences across the whole spectrum
- COSMIC can measure smaller software without distortion

Conclusions (cont.)

- The measurement results of the case study has provided illustrations of the distinct **sensitivity (agree better than smaller)** of both COSMIC and IFPUG FPA methods to both small and large variations of functionality in real-time processes.
- This explains in particular why there is **no** direct and simple convertibility ratio across methods **with real time software**:
 - convertibility depends on both the particular functional profile of the software being measured and the distinct sensitivity of each method to variations in the sample being measured

Note: there is a good relation with MIS software that I address in precedent articles. We should address here only real time.

Conclusions (cont.)

- What could happen with a large-scale project with a large number of transactions re-using existing data groups?
 - In this specific context, the number of transactions **could** be much larger than the number of data groups:
 - the number of transactions for IFPUG FPA **could** then have proportionally more points than the data groups,
 - while with COSMIC the total size of the functional processes **should** increase proportionally of the number of functional processes and
 - potentially COSMIC **could** probably have a larger size than the IFPUG FPA one.
- Further work on measuring large-scale software **will** help investigate this in more details

Thank You....

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