all data movements. Table 3 shows the functional size of sample use case „Search Flight" determined by using the COSMIC method.

The COSMIC method does not consider the complexity of the functional processes. Originally, it does not differentiate weights of the counted objects, this means, all data elements have the same score whether they are read or written, entered on a dialog or just displayed on a report. This is useful and simplifies measurement if data validation and preparation for input and output is characterized by similar complexity, for example, in case of transactional or real-time systems. However, it is typical for most business applications that the input of data represents a higher functional size than the output for read only purposes, due to the required checks regarding value range, consistency, and so on. Moreover, the functional size represented by storing data in a database consistently, is higher than by reading data.

The Data Interaction Point Method

Looking for a method which counts objects with the granularity of data elements by not requiring any estimation and which is suitable for measuring even large business applications, PASS Consulting Group developed the Data Interaction Point (DIP) method in 2006 [PASS 2013]. According to the standard ISO/IEC 14143 it focuses on use cases. The method considers data elements crossing the system boundaries and interacting with actors (human users, external systems or devices) as well as the databases where these data elements are stored. Contrary to the Function Point Analysis, no elementary processes were counted apart from the involved data elements, and no data structures apart from the elements they comprise:

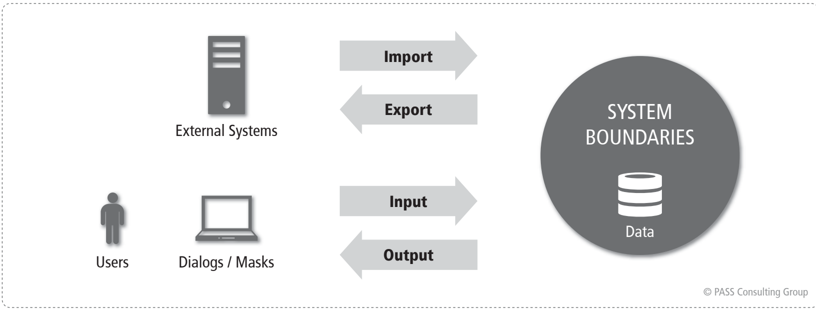

Figure 10: Objects to be counted by the Data Interaction Point Method

- Database: The method counts the number of different data elements which are involved in use cases.
- User interface: Objects to be counted are all data elements which can be entered or displayed on dialogs or masks within the scope of use cases.
- Interfaces to external systems or devices, that is, import or export functions: Here the method considers all data elements crossing the system boundaries to be processed or displayed in one of the related systems.

Similar to the Function Point Analysis, the weights of the objects to be counted correlate with the complexity of pre- and post-processing. The DIP method derives these weights from the usage of a data element, for example, depending on whether a data element enters the system via a dialog or an interface, where value and consistency checks are required, or is simply displayed or put out without preprocessing. Weights can be varied, depending on system types such as business or transactional/real-time applications. The following weights have proved their worth for applications with a strong focus on user interactions and dialogs:

- Dialogs/ masks: Value 3 for elements which can be entered by an actor (type: UI-I), 1 for elements which are only displayed (type: UI-O).
- Database: Value 3 for elements which can be changed by the considered system (type: DB), 1 for elements which are only read (type: REF).
- Interfaces/ imports/ exports: Values between 1 and 2 depending on the input/ output validations (types: IMP, EXP).

Table 4 shows the functional size of the sample use case „Search Flight" determined by using the Data Interaction Point method.

Use Case: Search Flight
Primary Actor: Traveler
Precondition: Traveler opened the Flight Search dialog

1) Traveler enters flight date	
date value	1 UI-I x 3 = **3**
2) Traveler enters first letters of the destination (name or code)	
sub-string of destination name or code	1 UI-I x 3 = **3**
3) System checks database table for matching airports and displays a list showing names and airport codes	
reference table with 2 attributes	2 REF x 1 = **2**
4) Traveler selects an entry of the list and clicks the „Search“ button	
ID of the selected list entry	1 UI-I x 3 = **3**
5) System sends a „Flight Search Request“ message to the CRS including date and airport code	
XML file including date value and airport code	2 EXP x 1 = **2**
6) System receives a „Flight Search Response“ message from the CRS and reads fields „departure time, arrival time, airline name, flight number, class, price, currency code“ of all included flight records	
XML file including departure time, arrival time, airline name, flight number, class, price and currency code	7 IMP x 1 = **7**
7) System displays all flight records showing these fields in a dialog table	
dialog table with columns „departure time, arrival time, airline name, flight number, class, price and currency code“	7 UI-O x 1 = **7**
	Functional size = 27 DIP

Table 4: Functional Size of Sample Use Case „Search Flight“ measured by DIP

Due to the relatively straightforward determination of the weights, measurement with the DIP method can usually be performed with less effort than, for example, with the Function Point Analysis. Moreover, counting can be automated easily because the data elements to be counted can mostly be derived from structural characteristics such as code pattern, database metadata, models, XML schemes, and so on.

Comparison of measurement methods

Figure 11 shows the results of measurements of different systems performed with the three functional size metrics described previously [3] [4]:

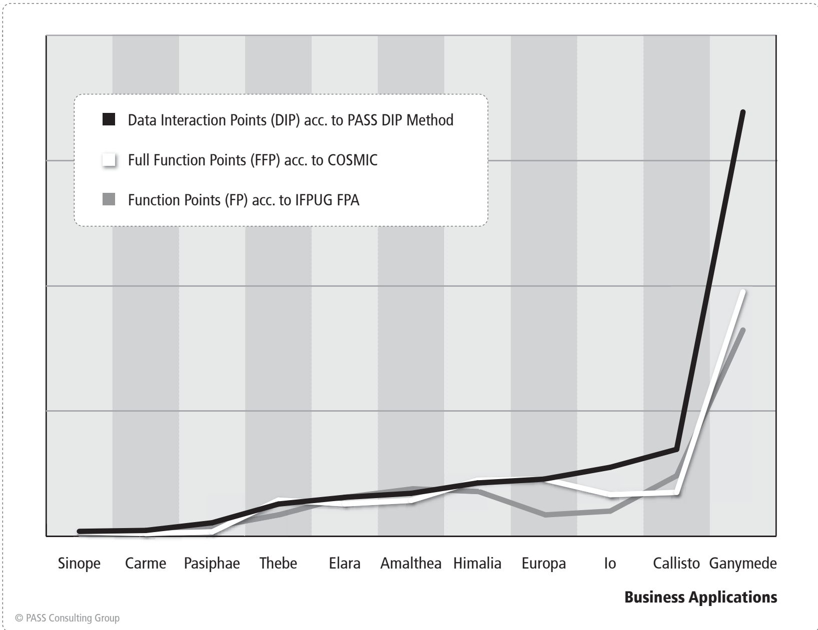

Figure 11: Comparison of size measurements of different systems by FPA, COSMIC and DIP

3 Source: Field study of the PASS Consulting Group, Competence Center Project Governance. Names of the systems have been changed.

4 The Function Point Analysis was performed according to the description of the OMG (OMG/FP 2013)