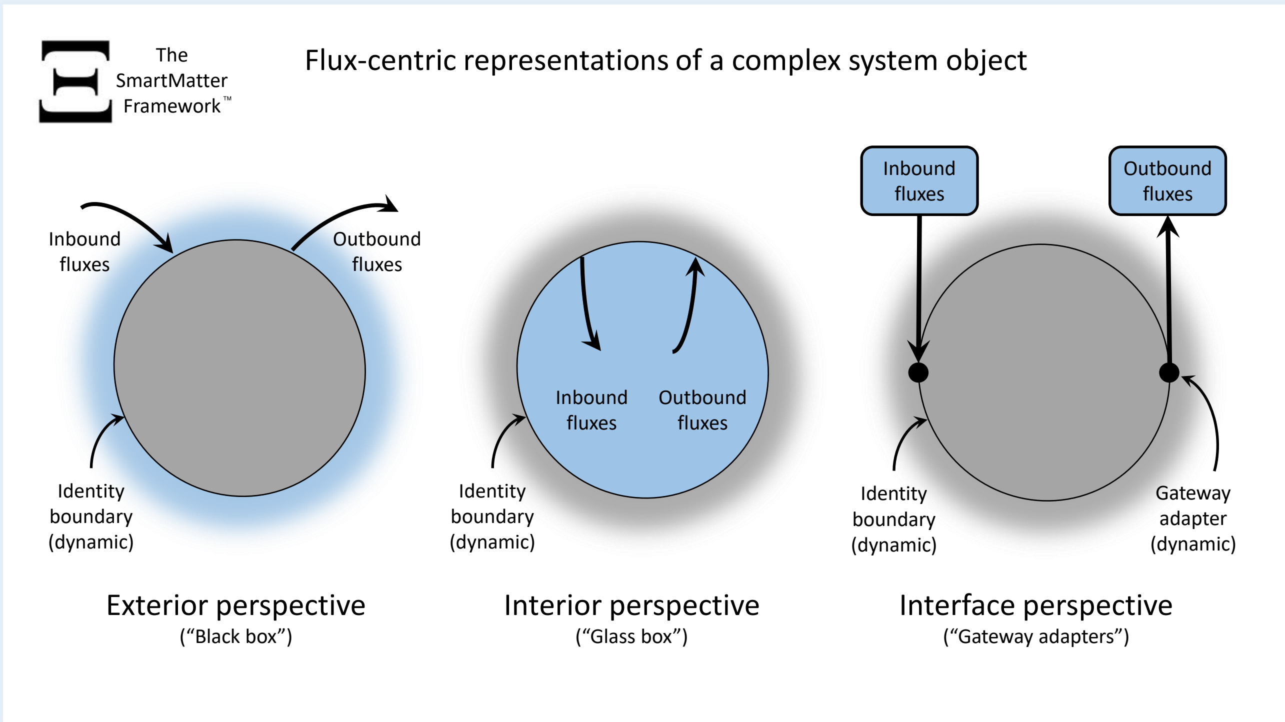
Complex System Object



Overview

The diagram shows three different ways of representing a single, uniquely identifiable complex system object. Each perspective selects and/or emphasises certain aspects of the same underlying object. The blue shading indicates those aspects of the object accessible to direct observation. The grey shading indicates those aspects which must be inferred from direct observations rather than being observed directly.

Relevance

These representations originated from the domains of Biophysics and Information Systems Engineering, but with care they may be mapped to any complex system object.

These representations are the origin of /.Xio, a type-free, scale-free knowledge asset which can represent an "object of care" in any knowledge domain.

Core concepts

Fluxes

A flux may be considered as any form of change or movement. The movement or transport of an object, the transfer of heat, and a chemical reaction are all examples of flux. Here, every element of the complex system object is defined in terms of different kinds of fluxes.

Identity boundary

This is a conceptual scope boundary for a complex system object which serves to delimit its unique identity in some way. It may be visualised as a "closed bag" which encapsulates the object. An identity boundary is a flux because it can vary in a dynamic manner.

Direction of movement

The direction of movement of a flux is defined in relation to the identity boundary. "Inbound" refers to movement from the exterior of the object to its enclosed interior. "Outbound" refers to movement in the opposite direction.

The exterior perspective

In its most basic form, the exterior perspective describes only the external face of the identity boundary along with the inbound and outbound fluxes, and it leaves all other fluxes undefined. This perspective is the “topmost” view or context diagram of an information system. It is sometimes called a “Black Box” perspective because it does not reference direct observables from the system’s interior.

The interior perspective

In its most basic form, the interior perspective describes only the internal face of the identity boundary along with the inbound and outbound fluxes, and it leaves all other fluxes undefined. For an information system, the interior perspective may also describe the sub-objects which lie one or more levels beneath the “topmost” context diagram. The interior perspective of an information system may be called a “Glass box” or “White Box” view. This is because it reveals internal details which are hidden from the “Black Box” view.

The interface perspective

The interface perspective references the observable fluxes at the dynamic identity boundary, and it leaves all other fluxes undefined. In this perspective, an object may be thought of as being equipped with “gateway adapters” which give it “plug-and-play” interoperability with other objects. For an information system, the inbound and outbound fluxes relate to many different concepts such as the system interfaces, channels, facades, types, styles and use cases. The interface perspective links to the Contract pattern, and has been shown to be the most effective way to develop massively complex and heterogenous systems of systems such as the global telecommunications network (1, 2).

Features of Interest

3D animation

The diagram shows the perspectives in a static, two-dimensional form. However, it is more useful to think of a perspective as an ongoing stream of “conceptual snapshots” of a moving, changing object - a little like a 3D animated cartoon.

Ambiguous viewpoints

The perspectives as shown are very general in nature, and they must be configured before use (2). Prior to configuration the perspectives are ambiguous and can be misleading (3). For example, configuration includes the specification of one or more stakeholder roles (1, 4). Without knowledge of these roles, it is difficult to determine whether the exterior perspective describes an observable phenomenon, an observer’s conceptual model of that phenomenon, or some combination of both. Similarly, the interior perspective is unclear as to whether an observer is situated within the complex system object, or whether they are observing the interior from the exterior through some sort of “window”. For the interface perspective, the direction of movement of a flux cannot be labelled “inbound” or “outbound” unless it is known whether the entire identity boundary forms a closed surface.

Scope creep

It is easy to imagine a combined representation which shows the interior perspective of a given object along with the exterior perspectives of its immediate sub-objects. Repeating this visualisation in a stepwise manner risks building a nested and aggregated collection of perspectives which extends inwards and/or outwards indefinitely. For any given conceptual model, scope may be controlled by defining a pair of identity boundaries which specify the topmost level and the lowest level of granularity of the applicable datatype model.

Inconsistencies

A complex system object may have many identity boundaries. This creates the unavoidable risk of inconsistencies, disconnects, and overlaps between different conceptual models. This risk must be managed with active specification, communication, and review techniques.

Gaussian surface

An identity boundary is a Gaussian surface. Such an abstract surface may be mapped to the wall elements of any observable thermodynamic system.

Bilayers

Try visualising one exterior and one interior perspective, both in their most basic forms, as a concentric, “back-to-back” pair. The two possible configurations resemble “bilayer” versions of the interface perspective. Bilayer interfaces may be mapped to observable phenomena such as biological membranes and the walls of soap bubbles.

Data description

The written English labels in the diagram are intended to help explain the representations. These keywords may be thought of as belonging to a separate data description or “annotation” perspective. For an information system, data description means that the label “fields” can be loaded with different content according to a configurable parameter. This technique allows the information system to display text labels in different languages on request, without the need to change the software.

Modelling tips

The concepts of fluxes and bounds give rise to several broadly applicable guidelines for analysis and modelling.

Tip# 1. Ask yourself “what is the object?”. The observable object of care (2) may be a single object or a population. Enterprise segments should be traced back to observable objects.

Tip# 2. Ask yourself “what are the object datatypes?”. Decouple the observable complex system object from the language-based facades of the datatype model (2, 5). See “Data description”, above.

Tip# 3. Ask yourself “what is the object history?”. Consider different kinds of fluxes in 3D space and across time (2).

Tip# 4. Remember the distributed nature of software component objects (6).

Relevant literature

(1) Jacobson, I., Booch, G., Rumbaugh, J. (1999). The Unified Software Development Process, Addison-Wesley.

(2) Fowler, M. (1997). Analysis Patterns: Reusable Object Models. Addison-Wesley.

(3) Brown, W.H., Malveau, R.C., McCormick, H.W., and Mowbray, T.J. (1998). AntiPatterns: Refactoring Software, Architectures, and Projects in Crisis. John Wiley & Sons.

(4) ISO/IEC/IEEE 42010:2011, Systems and software engineering - architecture description. (See the conceptual model at http://www.iso-architecture.org/42010/cm/).

(5) Moniz, J. (1999). Enterprise application architecture. Wrox Press.

(6) Brindley, H.M. (2022). Maslow’s Legacy. (https://www.researchgate.net/publication/361759275_Backstory_of_the_model_of_real_time_choice).