

Chapter 3

Cloud-Based Application Integration in Virtual Enterprises

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ABSTRACT

A key characteristic of a virtual enterprise (VE) is the heterogeneity of the applications that compose its enterprise information systems (EIS), since it builds on the EIS of the individual enterprises that are part of the collaborative network of that VE. This raises an application integration problem, which is even more serious than within any given EIS because a VE has a temporary nature, and therefore, integration requirements can change frequently. Current integration technologies, such as Web Services and RESTful APIs, solve the interoperability problem but usually entail more coupling than needed, since they require sharing data schemas between interacting applications, even if not all values of those schemas are actually used. The fundamental problem of application integration is therefore how to provide at most the minimum coupling possible while ensuring at least the minimum interoperability requirements. This chapter proposes compliance and conformance as the concepts to achieve this goal.

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INTRODUCTION

Enterprises are always seeking better ways of getting more agile and more efficient, to minimize costs and to maximize profits. The market landscape is increasingly more complex and diversified. Innovation, time to market, and adaptability are key characteristics that any enterprise needs to master to strive in a constant struggle with competitors.

A typical strategy is to concentrate on the core business and to establish collaborative networks (Durugbo, 2016) with other enterprises that have complementary goals. Traditionally, collaborations were long-lasting partnerships. Today, the market changes very swiftly and partnerships are much more limited in their time span, usually for the duration of some project or useful lifetime of a product.

This is the idea underlying the concept of *virtual enterprise* (VE), which corresponds to a temporary partnership between several enterprises with a specific set of goals (Kovács, & Kot, 2017). A VE can encompass several enterprises and the same enterprise can participate in several VEs. This organization provides a better governance of the partnership, since it is governed as an enterprise (although virtual), than having each enterprise govern all its partnerships without clear boundaries.

The goal is also to better support the integration of the applications of the *Enterprise Information Systems* (EIS) of the various enterprises, since there should a mission, a vision, and a strategy of the VE, which are not necessarily the same as those of each of the enterprises. However, if this is already difficult within one enterprise, the challenge is far greater when several enterprises are involved, particularly when creating and terminating VEs can occur within relatively short time spans.

Cloud computing platforms (Toosi, Calheiros, & Buyya, 2014) provide some dynamism in resource and application management, but do not solve basic problems such as enabling applications to understand each other's messages and to perform the intended actions.

An example of a domain in which such collaborations are of primordial importance is the fourth industrial revolution, commonly known as Industry 4.0 (Liao, Deschamps, Loures, & Ramos, 2017), entailing a vision of an intelligent factory where people, machines, processes, customers and suppliers are streamlined to produce and maintain smart products and services, thereby contributing to an improved society.

One of the main challenges that need to be overcome to turn this vision into a reality is *integration* (He, & Da Xu, 2014; Panetto & Whitman, 2016), the ability to meaningfully and efficiently cooperate with other subsystems in order to pursue the goals of the system as a whole. Integration can be seen at all levels of abstraction and complexity, from low-level cyber-physical systems (Zanero, 2017) to high-level enterprise value chains targeting the capabilities required by Industry 4.0 (Schumacher,

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