Part IV
Management of Peripheral Devices

Many enterprise processes are affected by the external physical environment, e.g., grapes cultivation, wine production, wine distribution and commercialization, just to name a few in the wine business domain. Data acquisition from the external environment is thus an important task. This part of the book discusses how data can be acquired from the external environment through specialized peripheral devices and made available to the networked enterprises information system for appropriate processing and decision. To allow a continuous, automated, and punctual monitoring of external environmental conditions, data acquisition can be performed through tiny and pervasive devices such as RFID (Radio Frequency IDentification) tags and wireless sensor nodes. In particular, sensor nodes are able to self-organize autonomously to form wireless sensor networks (WSNs) that can be used for continuous and fine-grained monitoring of large geographic areas, e.g., a vineyard or a wine cellar. However, as sensor nodes have a limited energy budget, power must be managed in a very efficient way to ensure an appropriate network lifetime. Efficient power management is required also when energy can be scavenged from the external environment, e.g., through solar cells. The following chapters discusses how peripheral devices, especially WSNs, can help in different phases of the wine business process. Challenges to be faced for their effective utilization in this specific application domain are addressed, and some novel solutions are proposed. Special emphasis is devoted to the way data are extracted from peripheral devices and made available to the information system of the networked enterprise. In the first chapter of this part (Chapter 15), entitled Wireless Sensor Networks for Monitoring Vineyards, Alippi et al. design a single-hop WSN for continuous and real-time monitoring of physical quantities that affect grapes production in a vineyard. Data acquired by sensors are transferred to a local Gateway (through short-range wireless communication) and, then, to the Data Server (through long-range wireless communication). An adaptive energy harvesting system for powering the Gateway node and, possibly, all sensor nodes as well is also proposed. Finally, energy conservation at sensor nodes is achieved through a polling-based communication scheme that allows sensor nodes to transition to sleep mode when communication is not required. If the geographic area to be monitored is very large, a single-hop sensor network may not be an appropriate solution due to the limited transmission range of sensor nodes. A more suitable option for such a scenario is a multi-hop sensor network. In Chapter 16 entitled Design, Implementation, and Field Experimentation of a Long-lived Multi-hop Sensor Network, Anastasi et. al design and implement an adaptive scheme to address the problem of energy conservation in a multi-hop sensor network for vineyard monitoring. The proposed approach adapts the duty cycle of sensor nodes depending on the (time-varying) operating conditions, thus minimizing their energy consumption. When dealing with WSNs, two important issues are related with (i) how to extract data from sensors, and (ii) how to manage and control the behaviour of each single sensor and the overall network. To solve these problems two alternative solutions have been investigated in the project. In Chapter 17, entitled Extracting Data from WSNs: a Service Oriented Approach, Bini et al. propose a service-oriented approach based on contracts. According to this approach, an application process can establish a service agreement with the underling

WSN. For the specific wine business domain three service contracts have been defined, i.e., *Periodic Measurement* (to report data periodically), *Event Monitoring* (to notify the occurrence of an event) and *Network Management* (to control the WSN behaviour). The alternative approach is described in Chapter 18, entitled Extracting Data from WSNs: a Data Oriented Approach. Schreiber et al. propose a middleware layer and a specific language to install queries and extract data from peripheral pervasive devices (e.g., RFID tags, sensors, WSNs). Specifically, three different types of queries are defined, i.e., *Low Level Queries* (to access data produced by sensor nodes), *High Level Queries* (to perform data manipulation operations), and *Actuation Queries* (to set parameters at sensor nodes). In chapter 19, entitled Optimal Design of Wireless Sensor Networks, Mura and al. illustrate how the issues of a WSN design can be tackled starting from the first phases of the design cycle. A tool supporting the design phase to perform architectural choices for sensor nodes and network topology, taking target performance goals and estimated costs into account, is described. Then, a methodology that allows analysing and optimising the power performances in a hierarchical fashion, encompassing various abstraction levels, is presented. Finally, in Chapter 20, entitled Enabling Traceability in the Wine Supply Chain, Cimino et al. address the problem of traceability in the wine supply chain. They propose a system that is able to systematically store information about products and processes throughout the entire supply chain, from the grapes grower to the retailer. The proposed system also manages quality information, thus enabling an efficient analysis of the supply chain processes.