Do BP Meet IoT Indeed?
The Academic versus the Industrial Perspective

Paul Grefen

Eindhoven University of Technology and G.DBA, Eindhoven, Netherlands

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Extended Abstract
The integration of concepts, architectures and technologies from the domains of business process management and the internet-of-things is interesting. It allows linking the more conceptual world of business processes that are formulated to achieve business goals and the more physical world of business resources that are needed to execute these business processes. This is especially relevant in application domains where business processes are designed to manipulate physical objects by means of physical resources: in manufacturing, machines transform materials into products; in logistics, vehicles transport goods; in mobility management, vehicles are used to transport people; in healthcare, devices are used to diagnose and cure patients; in real estate management, devices are used to track the status and use of buildings. Given our background, we take manufacturing as an example domain, where the application of advanced IT leads to the concept of *smart manufacturing* – but our line of reasoning holds for other domains as well.

Coupling business process management to event management by IoT enables building direct feedback cycles between the conceptual business control level and the physical business operations level, enabling business processes with higher levels of real-time behavior. This has positive effects on aspects like just-in-time operations, dynamic exception management, optimized resource utilization, and dynamic role resolution in process execution. This in turn enables business-level evolution, like the transformation of rigid supply chains into flexible demand chains in the manufacturing domain.

In research, various proposals have been made for the integration of BPM and IoT, which are typically based on the assumption of a close coupling between the BPM-side of an application design and the IoT-side of that design: BPM concepts and technologies are 'IoT-enabled' by extending them, or IoT concepts and technologies are 'BPM-enabled'. More often than not, this integration is executed from the viewpoint and research tradition of one the two sides, assuming that the other side can 'easily be glued on'. For example, from the BPM viewpoint, languages like BPMN are extended with basic IoT primitives (see e.g. [1]), and we extend BPM engines like Camunda to enact the functionality specified with these extensions. Next, we deploy these typically in small laboratory settings to show that things work in perfect harmony – that is: mostly from the BPM point of view.

In industrial practice, however, this perfect harmony usually does not exist – and neither does a slightly less perfect harmony. The typical reason for this is the fact that the two viewpoints exist in very different worlds – even in a single organization. Business processes and the systems to execute them are designed and managed by specialists in the world of enterprise information systems. IoT systems and their applications are designed and managed by specialists in the world of shop-floor infrastructures. Certainly in the manufacturing and logistics domains, we might call the BPM viewpoint the world of the 'white collar' specialists and the IoT viewpoint the world of the 'blue collar' specialists. People in both worlds often have different backgrounds (like information systems versus electronics or mechatronics), use different concepts, languages and models, and deploy different kind of technological infrastructures. This creates a divide that is often referred to as the OT–IT dichotomy [2].

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EMAIL: p.w.p.j.grefen@tue.nl
ORCID: 0000-0003-2880-5110

The OT-IT dichotomy leads to extensive confusion in industrial practice. When IT people speak about a ‘process’ in smart manufacturing, they may indicate an end-to-end business process that links the receipt of a customer order to a product delivery. When OT people use the same term ‘process’, they may indicate a script that instructs an industrial robot to physically execute a series of moves that is part of a single task in the context of a single manufacturing step. In our experience, the same term may be used in two contexts that are some five aggregation levels apart in terms of a process/task hierarchy and that use very different conceptual frameworks. When an OT specialist speaks about ‘connecting an IoT device’, (s)he may think about connecting the IoT device by a physical cable to a PLC or SCADA device, or perhaps about using low-level middleware based on OPC-UA [3]. When an IT specialist speaks about ‘connecting an IoT device’, (s)he may think about adding a symbol to a BPMN model or perhaps enabling the IoT device to connect to an ESB to which a BPM engine is connected. In practice, between the BPM engine and the physical IoT device may be a stack of several technology layers that were never designed to be all compatible. So, having BPM meet IoT in industrial practice is a bit harder than in an academic research environment.

But still: having BPM meet IoT in practice can bring many opportunities to industrial practice, as stated before. But we need to take some steps to make this work. The first step is to first identify ‘where everybody is’ that is involved in an innovation initiative. This helps identifying differences in terminologies, models and languages, and technological contexts. It is not wise to try and build a bridge without knowing what needs to be connected. The use of holistic frameworks, like RAMI4.0 in smart manufacturing [4], can help in this identification, but have their limitations when it gets to straightening out details. Using a clear, well-structured, and commonly agreed-upon architecture for the entire initiative can bring things a step further. This architecture needs to address multiple dimensions, covering at least the system, process and data dimensions [5], and preferably the platform and organization dimensions as well [7]. The use of a reference architecture [6] as a basis for the design of a concrete architecture is strongly recommended here [3,5]: it avoids reinventing the wheel over and over again and also brings a ‘neutral’ starting point between the two perspectives. Using a well-structured architecture helps in balancing between top-down and bottom-up design steps – using both directions is often hard to avoid in a practical project where new goals are defined but an existing technological context needs to be (partly) reused. Bringing vision and legacy together requires some thorough understanding.

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No AI tools were used in writing this paper.