An Alignment Perspective on
Architecture-driven Information Systems Engineering

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Abstract

This article provides a discussion on architecture-driven information systems engineering from a Business-IT alignment perspective. We do so by trying to develop a more fundamental understanding of the essence of Business-IT alignment. We try to find this understanding by viewing Business-IT alignment as the alignment between two co-evolving systems. An alignment that should take place at the strategic, the tactical as well as the operational level of these systems.

1 Introduction

The prevailing conditions under which most organisations currently operate have a tendency to evolve constantly. Reduced protectionism, de-monopolisation of markets, deregulation of international trade, privatisation of state owned companies, increased global competition, cross-border merges, the emergence of new trade blocks, the introduction of common currencies, all contribute towards this increasingly dynamic business environment. To improve their chances for survival, organisations need the ability to quickly adapt themselves to such socio-economic developments.

Organisations usually make use of (largely computerised) information systems to provide in their information processing needs. When an organisation evolves, these information systems should be able to evolve naturally. In practice, this has proven to be a difficult task, in particular where it concerns the computerised (parts of the) information systems, i.e. information technology (IT). Ideally, IT should empower an organisation with the ability to go out and seek new challenges. However, one of the current dilemmas of IT seems to be that in most cases it smothers an organisation's ability to change rather than supporting it. While it is quite reasonable to say that advanced computerised information systems should lead to revolutionary improvements in the flexibility and effectiveness of organisations, organisations still find themselves anchored to their pre-existing information systems. Quite often, these systems are the embodiment of the prevailing cultures and structures of the organisation's past. These systems tend to have an almost tangible monolithic nature that would be a feast to software archaeologists.

An organisation can deal with changes in their environment in a variety of ways. While some may try and continue their business *as usual*, others may choose to embrace the new developments and try to exploit their potential to their fullest. Neither approach is a guaranteed way to success or failure. Embracing new developments too early may lead to organisational chaos and decline, while waiting too long may result in missed business opportunities. Already in [Kee91] and [TC93], an elaborate discussion can be found on the changes in context and culture that are occurring inside organisations as well as in their environments as a result of different socio-economic changes in combination with technological developments in IT. Tapscott [TC93] proposes an architectural approach as a

solution to make the needed changes to the organisational structure and in particular IT. These new demands on IT in the new and rapidly evolving world, can be summed up by quoting [Tap96]:

> *In the past an architecture was really the design of a system that had been created to meet specific application needs. In the new business environment, organisations have little idea what their application needs will be in two, let alone five or ten years. Consequently, we need architectures that can enable the exploitation of unforeseen opportunities and meet unpredictable needs.*

Developing information systems in such rapidly evolving contexts becomes like shooting at a moving target [PW95a, PW94, PW95b]. This requires us to look at organisations and their information systems as evolving systems [Pro94]. Ideally, these systems should be in a constant state of co-evolution.

In the past years, IT industry has built up practical experiences with different approaches to, what could be referred to as, architecture-driven information systems engineering [Kee91, TC93, PB89, HV93, Mag95, Sch97, Pro98, BLW98, Sch98, Sch98]. In other words, the process of designing, realising and implementing information systems, using an architecture-driven approach.

A theme that seems to be common to most of these approaches, is that an improved alignment between an organisation's activities and the IT systems used within the organisation is considered imperative. In literature this is usually referred to as business-IT alignment or as strategic alignment. This article takes the view that Business-IT alignment is at the heart of architecture-driven information systems engineering. From this perspective, we aim to develop a more fundamental understanding of the essence of Business-IT alignment. We try to find this understanding by viewing Business-IT alignment as the alignment between two co-evolving systems. An alignment that should take place at the strategic, the tactical as well as the operational level of these systems.

The structure of this paper is as follows. Section 2 briefly reviews the notion of Business-IT alignment. In section 3, the notion of systemic alignment is proposed as a way to more fundamentally underpin the concept of alignment. We continue in section 4 by adding a temporal horizon to this, considering the different planning horizons at which to view systems and persue their mutual alignment. Before concluding, section 5 sketches the relationship between alignment and the overall processes involved in architecture-driven information systems engineering.

2 Business-IT Alignment

Ideally, business strategists should be able to focus solely on the development of a business, while IT plays the role of a catalyst. It can indeed be seen around us how organisations try to move away from technology-driven architectures to more business-driven architectures. A trend which was already identified in e.g. [BBM$^+$95].

2.1 Organisational maturity

Tapscott [TC93] argues that organisations move between three levels of maturity, while IT should act as one of the essential enablers of this process. In Figure 1, taken from [TC93], these levels are depicted. By redesigning their business processes, organisations will be able move to a situation in which teams can perform better. This development leads to high-performance business teams, where the focus is on the use of IT to enable teams to perform business functions. This requires a shift away from a hierarchical view on organisations to a more team based view. The next shift involves the integration of the business teams to an integrated whole, leading to an integrated organisation. The role of IT in these cases, is increasingly one of being an enabler; from cost centre to profit centre. By linking their systems to other organisations, in particular customers and suppliers, an organisation can finalise the paradigm shift, and become an extended enterprise. In [SBK$^+$96], the Gartner Group supports this view by stating:

> *"By 2001, several iterations of technical architectures will allow the evolution of enterprises to a constituency-driven inter-enterprise business environment (0.7 probability)."*

All these shifts and developments pose new requirements on the IT function. These shifts, however, will not come from IT alone. As Michael Hammer argued in his seminal paper: *Re-engineering work: don't automate, obliterate* [Ham90], improving the flexibility and efficiency of business processes is more than just using IT to make it go faster. IT is only part of the answer, it should not be looked upon as the sole bringer of solutions, but rather as an enabler. Investments in a re-engineering of the business and better business-IT alignment will be needed just as well. However, organisational change should be business-driven, and not (solely) IT-driven. The
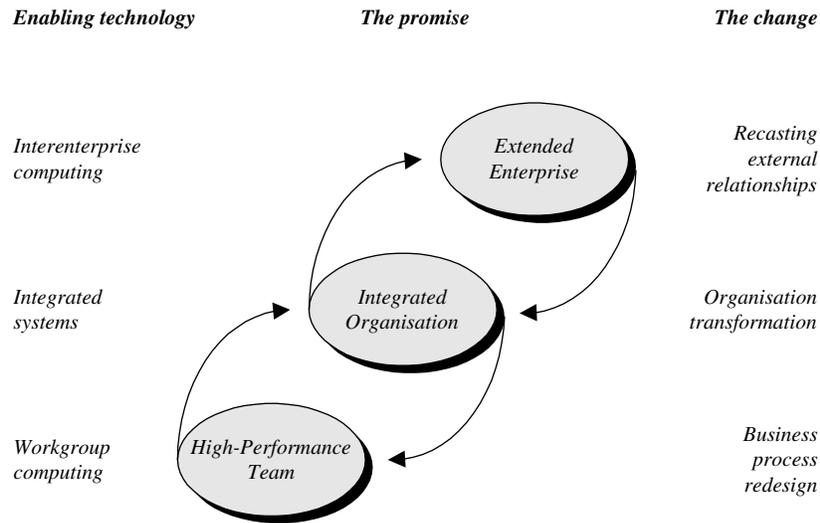
Figure 1: The enabling effect of information technology

outcry for IT that enables organisational change rather than inhibits it is clearly louder than ever. IT, and associated application development, should therefore be driven by the needs of the business.

2.2 Strategic alignment

The importance of a good alignment between business and IT is discussed by several authors. For example, Tapscott & Caston [TC93] and Keen [Kee91], and they are certainly not the first in doing this. In [PB89], Parker and Benson already discussed the need for strategic alignment between business and IT strategies. They argued that information technology planning and strategic considerations are part of a circular process as depicted in Figure 2. In this process, a distinction is made between the business domain on the one side, and the technology domain on the other side. Business planning drives how an enterprise will be organised, which should on its turn drive the technology planning to support the business. Technology planning leads to the discovery of further opportunities for future uses of technology, which will influence further business planning and strategy.
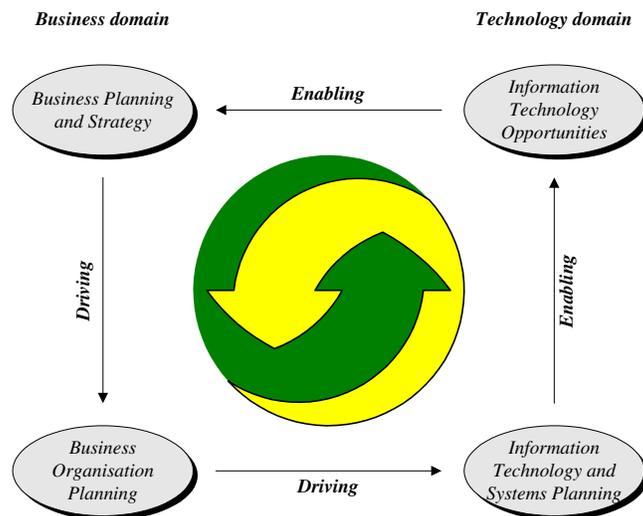
Figure 2: Strategic alignment cycle

Parker and Benson also recognised the fact that this cyclic process may not work on an organisation-wide scale. Organisations usually do not operate in a way that supports a 'monolithic' view of their information systems.

However, they also argue that these cycles can be specialised to a specific line-of-business, or a specific business unit. In other words, the cycle of Figure 2 can be applied to smaller, more focussed, scopes within an enterprise.

The views of Parker and Benson were refined further by Henderson and Venkatraman [HV93]. On the importance of alignment between business and IT strategies, they argue:

> We argue that the inability to realise value from IT investments is, in part, due to the lack of alignment between business and IT strategies of organisations.

They also conclude:

> Strategic alignment is not an event, but a process of continuous adaptation and change.

Below we will see how alignment between business and IT is not something that is limited to the strategic level only. Alignment between business and IT is needed on all levels, including tactical and operational levels.

2.3   Strategic focus

Having a better understanding of the relationship between business strategies and IT strategies and their realisation would also allow for the development of reference models and reference solutions fitted to the needs of specific strategic archetypes. To further illustrate this point consider Figure 3, which is taken from [TW97]. Treacy and Wiersema argue that organisations should try and focus on one of the three following extremes:

Product leadership   These organisations aim to provide the best and/or most innovative products. An example of such an organisation would be Nike.

Operational excellence   These are typically organisations, which strive to provide a basic level of service in the most efficient way. McDonalds would be a prototypical example of an organisation striving for operational excellence.

Customer intimacy   Organisations, which are customer focussed and aim to provide (complete) solutions for these customers. An example of such an organisation would be Rolls Royce.
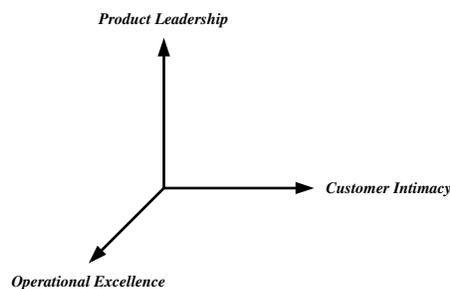

Figure 3: Strategic focus

When developing a business strategy, organisations will most likely focus on one of these three extremes. The IT strategy will be a resultant of the business strategy and somehow will reflect this latter choice. Even more, depending on the choice, certain IT components will come into focus or move out of focus. This would allow for the development on reference models geared towards different strategic focusses. For example, organisations aiming for customer intimacy will probably be looking at data-warehousing, call-centres and WWW technologies. An organisation striving for operational excellence will most likely cling to proven technologies, and shy away from modern middle-ware technologies.

3   Systemic Alignment

Although the importance of alignment between an organisational system and its (computerised) information systems has been argued extensively, a precise definition of what the alignment between these systems should entail has not been provided yet. To gain a more fundamental appreciation of the issues involved in alignment, a brief discussion on the notion of alignment in the context of information system design is provided below.

3.1 Types of systems

An organisation may make use of one or more information systems to provide in its information processing needs. These information system do not necessarily have to be fully automated systems. The word information system does *not only* refer to computerised information processing activities, but may includes human as well as computerised information processing. Some authors refer to this as an information system in the *broader sense* [RV90], while the computerised information system is also referred to as an information system in the *narrower sense*.
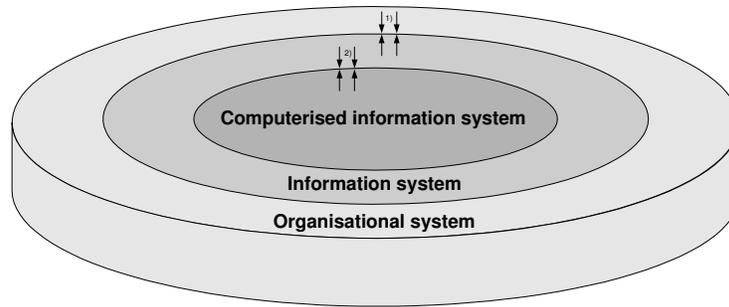

Figure 4: Three systems involved in business-IT alignment.

Usually, the information processing activities involved will be conducted by a combination of human and computerised actors. In this context it, therefore, appears to be that there are three systems that need mutual alignment:

- the *organisational system* (such as a business),

- the *information systems* contained within the organisational system and

- the *computerised information systems* (the information technology) contained within the information systems.

This is illustrated in figure 4.

With the distinction of the above three intertwined systems, business-IT alignment can be seen to comprise the following two forms of systemic alignment:

1. the alignment between an organisational system (the business) and its information systems,

2. and the alignment between an information system and the computerised information systems (the information technology) contained within it.

See the arrows marked 1) and 2) in figure 4.

3.2 Quality criteria

The alignment issue may now be translated to the question: *how can a sub-system be aligned to its super-system?* As a sub-system can be seen as a provider of services to the super-system, one reasonable way of looking at their alignment is to express this in terms of quality properties. The rationale is that the super-system will 'expect' the sub-system to meet certain quality criteria. The better the match between the quality as *expected* by the super-system and the quality as *offered* by the sub-system, the better the sub-system is aligned to the super-system. This also implies that whenever the alignment between a sub-system and a super-system needs to be evaluated, these quality requirements should be articulated.

The following list of quality characteristics is based on the work done in [FV99], and originates from the ISO-9126 Standard [ISO01] and takes the Extended ISO-model [ISO96] into account for their sub-characteristics.

- *Efficiency*

  The relationship between the level of performance of the system (or a component) and the amount of resources used, under stated conditions. Efficiency may be related to time behaviour (response time, processing time, throughput rates) and to resource behaviour (amount of resources used and duration of such use).

- *Functionality*

  Functionality bears on the existence of a set of functions and their specified properties. The functions are those that satisfy stated or implied needs.

  Sub-characteristics of functionality are: suitability, accuracy, interoperability, compliance, security and traceability.

- *Reliability*

  The capability of the system (or a component) to maintain its level of performance under stated conditions for a stated period of time. The mean time to failure metric is often used to assess reliability of computerised systems. The reliability can be determined through defining the level of protection against failures and the necessary measures for recovery from failures.

  Sub-characteristics of reliability are: maturity, fault tolerance, recoverability, availability and degradability.

- *Maintainability*

  Maintainability bears on the effort needed to make specified modifications to the system (or a component). Modification may include corrections, improvements or project to changes in environment, and in requirements and functional specifications.

  Sub-characteristics of maintainability are: analysability, changeability, stability, testability, manageability, reusability.

- *Portability*

  The ability of the system (or one of its components) to be transferred from one environment to another.

  Sub-characteristics of portability are: adaptability, installability, conformance, replaceability.

- *Usability*

  Usability bears on the effort needed for the use of the system (or one of its components) by the actors in the surrounding system.

  Sub-characteristics of usability are: understandability, learnability, operability, explicitness, customisability, attractivity, clarity, helpfulness and user-friendliness.

Using these quality characteristics, we can (informally) define that a sub-system x and a super-system y are aligned at a certain point of time t, iff the quality properties that are implicitly or explicitly required by y on the services provided by x to y are indeed provided by x.

A complicating factor is that over time, the quality criteria as demanded by the super-system are susceptible to change. In other words, even though x and y may be aligned at t, they may fall out of alignment when y evolves and consequently poses other quality properties on x. This requires x to evolve as well. To really allow the super-system and sub-system to co-evolve, the potential evolution of the quality properties should be taken into account as well. This may be done by not only taking the quality properties as posed by the super-system into consideration, but also the expected stability/evolution of these properties.

Two quality characteristics that maybe used to illustrate the need for business-IT alignment are adaptability (a sub-characteristic of portability) and changability (a sub-characteristic of maintainability). Due to the dynamic socio-economic environment in which organisations have to operate, they need the ability to quickly adapt themselves to this changing environment. This also requires that their (computerised) information systems are able to co-evolve with the organisational system. Typical examples of systems hampering changes to the surrounding organisational system are legacy systems. As a legacy system are, by their definition, hard to change, changes to the surrounding system are likely to be hampered by the legacy system.

3.3   System perspectives

The quality properties, as discussed above, may be applied to different aspects of a system. We finalise this brief discussion on systemic alignment by considering which aspects of a system may play a role when aligning systems.

The English language provides a class of words called the *interrogatives* [TM86]:

Which, when, how, what, why, where, whose, ...

These words may be used to formulate questions concerning the different aspects of a system that may be taken into consideration. These words give a good indication of the set of possible aspects of a system that may be relevant to express the requirements on systemic alignment. In [Zac87, SZ92], this idea has been applied to identify the different aspects of a system that may be covered by modelling techniques. By using questions based on the interrogative words, insight may be gained into different essential aspects of the system, such as:

Actors, subjects, timing, process, functionality, rationale, purpose, locality, structure, ownership, ...

These different aspects lead to even-so-many perspectives from which a system may be viewed. This is illustrated in figure 5. In each situation where a sub-system should be aligned with its super-system, quality criteria may be identified for each of the perspectices defining when a sub-system is considered to be aligned with its super-system. Note that not all quality properties will equally apply to all of the possible perspectives.
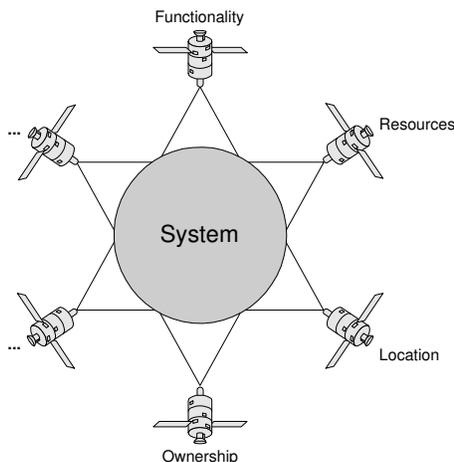

Figure 5: Different perspectives on a system.

An interesting question is of course: *which perspectives should be taken into account to achieve a good alignment?* Taking all perspectives into account would indeed be a laborious task, if not sheer overkill. In practice, a selection needs to be made on the perspectives that deserve the most attention in a specific situation. For example, Tapscott and Caston [TC93], identify the following perspectives on an IT architecture: *business perspective*, *work perspective*, *information perspective*, *technology perspective* and *application perspective*.

What we argue is that the set of perspectives that should be taken into account, as well as the set of relevant quality properties, are very much dictated by the situation at hand. For example, in knowledge-intensive application areas with informal and ad-hoc work processes, it may be wise to take the position of individual human actors (the human perspective) into account to achieve proper business-IT alignment. In other situations, however, for instance when dealing with well defined and explicit work processes, a work-process perspective may be of more relevance than a human perspective.

4   Planning Horizon

As stated before, we view business-IT alignment as being at the heart of architecture-driven information system engineering. Different authors, for example [HV93, Sch97, BLW98, Ste98], agree on the fact that business-IT alignment should start out from the strategic level. In other words, the systemic alignment needed between the organisational system, the information system and the computerised information system, should be achieved first at the strategic level and should then advance down to the tactical level and eventually to the operational level.

To achieve alignment between two systems at a strategic level, the strategy's underlying the future developments of both systems should be aligned. A strategy concerning the future developments of a system is essentially a high level design of the system, focussing on its key structural, functional and quality properties.

Design-artefacts, the elements that make up the design of a system, may have different levels of concreteness. They may range from prescriptive to descriptive with regards to the design they portray:

- *Prescriptive artefacts*

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Design artefacts that express the rules, or principles, to which the final design of the system should *adhere* to, without explicitly defining *what* the final design should actually look like. These artefacts tend to be used to articulate the visionary aspects of a design, and are usually referred to as construction principles, architecture principles, or policies [Kee91, TC93].

Examples:

- Our information systems should utilise standard, shareable, reusable components across the enterprise.
- Once captured, information should be stored and exchanged using electronic means such that manual transcription and re-entry are avoided.

- *Descriptive artefacts*

  Design artefacts that define *what* the design looks like. These artefacts usually take the form of models.

A design on a strategic level is likely to focus on design artefacts that take a *prescriptive* angle at the design in order to articulate the visionary aspects of a strategy. A design on the operational level is likely to only include *descriptive artefacts*. The latter design will most likely have a one to one correspondence to the actual operational system. This has been illustrated in figure 6.
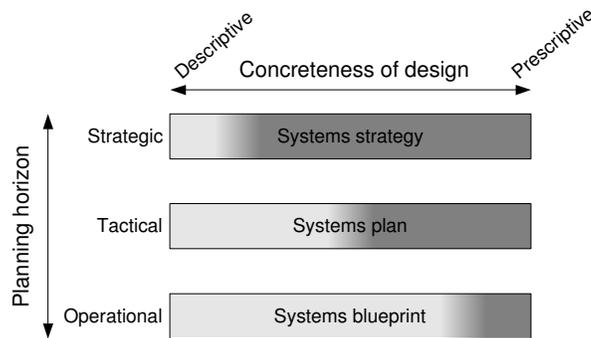

Figure 6: Three levels of system design.

Figure 6 also identifies a specific type of design for each of the typical planning horizons:

1. The *system(s) strategy* defines the direction in which system(s) are planned to evolve from a longer term (strategic) perspective.

   As, for example, argued by Mintzberg in [Min94]:

   - strategy is a continual, incremental process of setting and resetting organisational direction;
   - strategy should not be elaborate or detailed, because we cannot anticipate the future in detail;
   - strategy is a dialogue rather than a document;
   - strategy and planning should be done by business managers, not "strategic planners".

   Mintzberg [Min94] stresses the fact that a *system(s) strategy* should be seen as a directional design. Furthermore, this high level design should be seen as the subject of a continuous dialogue between business managers, rather than a fully elaborated document. If expressed as a document, it should really be covered with coffee-stains and scribbles with additional ideas, discussions and refinements. In other words, it should be a perpetual discussion document.

2. The *system(s) plan* provides the translation of the system(s) strategy to a more concrete level. It identifies the system(s) needed in the shorter term that are in line with the longer term strategic view. A system(s) plan may identify multiple plateau's that identify different stages in the development of the system(s) portfolio over time, and should be viewed as a *zoning plan* or a *city plan* for geographical development.

3. Finally, the *system(s) blueprint* defines the design of particular (operational) systems. Where the system(s) plan corresponds to a *zoning plan*, a system(s) blueprint can be seen as the pendant of the blueprint of a building.

To achieve a continuous alignment, the process of alignment between sub-system and super-system must be a continuous process itself, taking strategic, tactic and operational levels into consideration. This clearly differs from traditional *information planning* approaches, which make this process into a project of a few months that should be executed once every n-years, usually leading to thick reports that are obsolete at the moment they are finished. For business-IT alignment, this leads to the situation as depicted in figure 7.
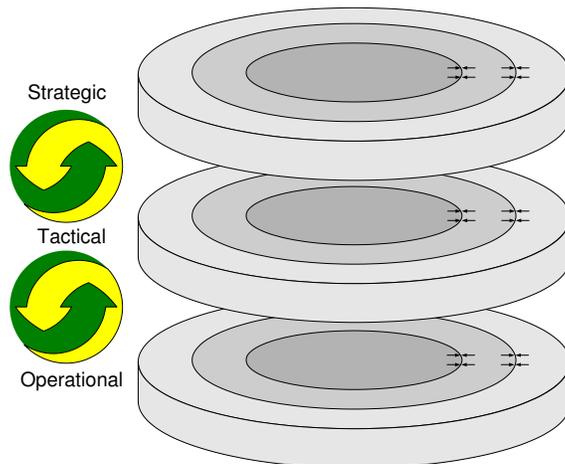

Figure 7: Business-IT alignment at three levels.

It is interesting to see that, as the field of business-IT alignment has mainly originated from a business-studies perspective, the area of alignment that has received most of the attention thus far is the alignment between the organisational system the information systems. The second area of alignment dealing with the alignment between the information system and its computerised subsystem, which is more the computer science side, has not received much attention yet. Novel approaches to computerised information system design, as may be found in e.g. [DW99, JBJ99], do not explicitly pay attention to the issues of alignment as raised above. If they do, this is usually focussed on the *system blueprint* level, but hardly ever on the *systems plan* or the *systems strategy* level.

5   Architecture-Driven Information Systems Engineering

This finally brings us to the notions of architecture-driven information system design. After the discussion above, we may now define architecture-driven information systems engineering as:

> *Designing, realising and implementing (computerised) information system(s) that are in-line with:*
>
> > *a long-term vision (architecture) of the system(s), their organisational context and their mutual alignment.*

The long term vision mentioned can be found in the *systems strategy* and the *systems plan*. In line with the above discussion, the architecture-driven engineering of information systems can be seen to involve the following three key architectural processes:

1. The articulation of some *systems strategy* for the organisation system and the portfolio of (computerised) information systems serving the organisation.

2. The formulation of a *systems plan*, in-line with the *systems strategy*, defining the concrete direction in which the portfolio of (computerised) information systems, in its organisational context, should evolve in the intermediate future.

3. The formulation of *system blueprints*, in-line with the *systems plan*, for those (computerised) information systems that are to be developed in the near future.

Note that these processes will not only be concerned with the design of the desired information systems portfolio, but also require analysis of the existing situation and design of effective migration scenario's. Needless to say that these processes should be continuous rather than a returning event as was the case in traditional *information planning*.

6 Conclusions

This article provided a discussion on architecture-driven information systems engineering from a Business-IT alignment perspective. The ideas presented in this article are far from complete as the article is a report on work in progress. The author would like to invite all readers to comment on the ideas presented. It is the author's hope that the ensuing discussion will lead to a further improvement in our understanding of the essence of Business-IT alignment and its role in architecture-driven engineering of information systems.

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