Frontloading: Virtual Quality Assurance for Improved Service Launch Processes

H. Lehmann[1], U. Beyer[2], S. Cohnitz[2], U. Bub[1]

[1] Deutsche Telekom Laboratories
Ernst-Reuter-Platz 7
10587 Berlin, Germany

[2] Fraunhofer-Institut für Intelligente Analyse- und Informationssysteme
Schloß Birlinghoven
53574 St. Augustin
H-Lehmann@telekom.de
uwe.beyer@iais.fraunhofer.de
simon.cohnitz@iais.fraunhofer.de
Udo.Bub@telekom.de

Abstract: Swift and frictionless launches of new products are a decisive capability of future telecommunication providers, especially in an all-IP production environment. These processes are characterized by nonlinear, network-like dependencies of multiple stakeholders (e.g. marketing, product management, IT, production, multi-project management, controlling and others) and critical technical resources such as IT systems, production platforms, customer relationship management systems and technical elements. As these nonlinearities cannot be governed by simple guesses, a systematic a priori quality assurance of launch processes must necessarily involve comprehensive model-based simulations. However, a fine-grained deterministic model of the technical landscape of a telecommunication provider must fail due to complexity and changeability with time. The presented paper proposes – utilizing aspect-oriented modelling and arbitrary hierarchical scales – a slim methodology and concurrent software tool for such a quality assurance..

1 Introduction: Interdependencies and Launch Processes

Telco products have the peculiarity that they are never complete: each time a number is dialled, for instance, complex technical procedures are invoked. The separation of a consistent customer-facing product representation (i.e. dialling the number), and hidden and changeable resource services composing the product (i.e. producing the voice connection), is at the core of the *"next generation"* Telco production paradigm. The manifold of the resource services compose, in specific configurations, all possible products whence the interdependency issues arises whether the critical resource services are available for the specific product requirements. Further interdependency issues arise in connection with multi-project management, controlling, product management – to name but a few. As 70% to 80% of a product's overall lifecycle costs are fixed in the early planning phase [RH07], a gauging of these essential interdependency effects is critical for the economical and technical performance of the product [PSM02]. For such an estimate, simple linear forecast techniques must fail due to the fact that these interdependencies have a strong nonlinear character [Ma99]. The only way to approach this phenomenon systematically must involve a technical enterprise model. Furthermore, the paradox of determining lifecycle parameters without real-life experiences does not only concern product launches, but also migrations of technical platforms, IT systems or any other alterations of the technical status of the enterprise. For obvious reasons (extent, complexity, changeability with time, maintenance efforts) a model describing the technical status of the enterprise cannot – with a sufficient coverage – be constructed in a fine-grained, bottom-up way. Faced with this dilemma, it is the principal concern of this paper to present an alternative approach: a modelling method and a concurrent software tool for virtual *a priori* quality assurance of large-scale technical enterprise alterations. This approach will be summarily defined as *frontloading*. This term stems from the automotive industry where similar techniques are well established [Sei08] and describes the shift from experience-based *ad hoc* remedies for complexity-driven project failures to a simulative model-based approach as presented here. In the following paragraph, the underlying modelling approach will be developed and discussed.

2 Boundary Conditions and Principal Solution

From the heuristic reasoning above it is clear that any *frontloading* approach for a complex technical enterprise alteration will require a substantial amount of modelling work, data capturing, stakeholder interviewing etc. before it can produce sensible results. This effort shall be summarized as the *frontloading* procedural costs. The fundamental question, than, is whether this total cost is favourable compared to the accumulated cost of the alternative, empirical and experience-based trial-and-error procedure. Schematically, this trade-off is depicted in fig.1: The areas A1 and A2 correspond to gross measures of the different distribution of all involved cost effects, including the difficult-to-measure ones such as time-to-market effects.

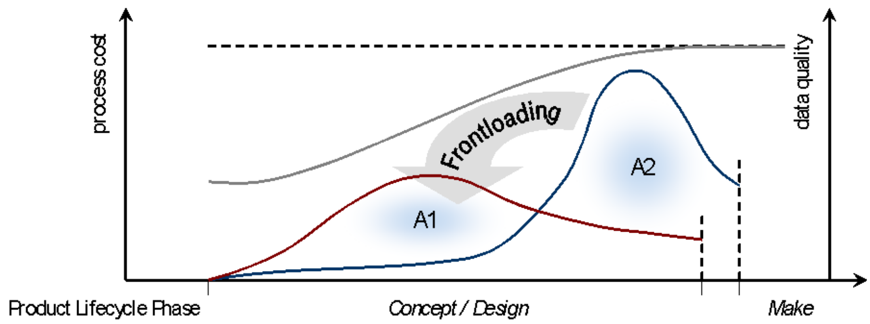

fig 1: The twofold principal effect of *frontloading*: process costs are shifted to earlier lifecycle phases and their overall measure decreases. Additional cost contributions to A1 arise from the data inaccuracies in the early project stages. Note, that *frontloading* necessarily involves operating on the poorer data quality of earlier project stages. The principal economic evaluation of the *frontloading* approach derives from comparing the cost integrals *A1* and *A2*.

It will be argued below that the constructivist approach followed in this work is well suited to minimize the costs associated with A1. In order to derive, or, rather justify this approach, important boundary conditions for the *frontloading* approach shall be discussed and analyzed. These are grouped into organizational-cultural constraints and topical requirements towards the tool.

2.1 Organizational-cultural constraints

Frontloading will rely on the engagement of a broad variety of enterprise departments. The relations between these departments with respect to product lifecycle management are constituted in a fixed and comprehensive process and role framework [Sch05]. Any departure from this constitution potentially leads to loss of focus and might result in cross-departmental friction. It is, therefore, mandatory that the *frontloading* method interferes minimally with the given enterprise constitution. Specifically, this leads to the following constraints and demands:

- Process connectivity: The proposed methodology will, obviously, have a bearing on the existing launch processes concerning products, services, or, resources. These have to be left intact – any effects of a *frontloading* will have to have the temporal extension zero in the process landscape. It should be strictly understood as a virtual quality assurance of project steering decisions. Furthermore, the tooling will need to be able to connect to the digital formats of a broad spectrum of project management tools – as input as well as output.

- Stakeholder comprehensiveness: It has been mentioned above that launch and alteration processes involve a broad variety of stakeholders. Their respective roles, modes of work, dependencies and organization have to be mapped unambiguously, comprehensively and democratically. A tilt of *frontloading* towards particular players has to be avoided in order to maintain the neutral quality of the approach and, thus, guarantee unbiased results.

- No false promises: Unrealistic expectations towards the *frontloading* approach have to be countered. When working with a lesser data quality (see fig. 1: estimates, fuzzy variables [YZ92], varying degrees of coarse-graining) and without standard algorithms, results can never assume deterministic decisiveness. A further principal restriction has to be considered: Simulations on a given set of data cannot predict events lying qualitatively outside of this set. Linear extensions of data are possible, but in complex and nonlinear dependencies they will not represent reality. The trustable basis for decision support will derive from ensemble simulations covering a wide field of possible events.

2.2 Topical requirements

Apart from the constraints discussed above – and, partially, as a consequence of them – , a number of topical requirements towards the tooling arise.

- Minimal maintenance effort: This is a critical constraint deriving directly from the organizational-cultural constraints discussed above: On the one hand, *frontloading* requires a sufficiently broad base of enterprise data to be provided; otherwise the simulation results will become meaningless. On the other hand, disproportional high efforts for maintaining this data base will render the approach impractical and ineffective; acceptance in the concerned departments will dwindle. (In terms of fig. 1, the area *A1* as the measure of *frontloading* procedure costs will be increased rendering the approach eventually ineffectual.) An optimal compromise has to be found.

- Learning aptitude: Related to the maintenance constraint discussed above, it is demanded that consecutive applications of the *frontloading* approach lead to a growing knowledge database. A mechanism has to be devised to identify reusable parts of previous *frontloading* runs while at the same time avoiding relying on obsolete data.

- Scalability: Launch projects in the Telco world can have vastly differing scales – from simple tariff changes to infrastructure programs involving billions of euros (e.g. glass fibre networks). This feature is in sharp contrast to manufacturing industries, where launches will always be of comparable complexity. In principal, any of these changes should be amenable to *frontloading* – the tool will have to reflect this flexibility. It should be reiterated, though, that meaningful *frontloading* effects require a certain minimal complexity of the project; otherwise the cost balance in fig. 1 is always tilted in favour of the experience-based trial-and-error procedure.

- Topical adaptability: Following directly from the point discussed above, tool and method have to be topically adaptable towards the potentially vastly differing application scenarios. Here, adaptability means the capability of the tool to allow different aspects of the project being emphasized in varying degrees.

- Fuzziness and coarse-graining: *Frontloading* tool and method will have to cope with inaccuracy and incompleteness of data (see fig. 1) – this is the price that has to be paid for getting involved in early project stages. Various mathematical techniques are known for dealing with data qualities of this kind – apart from the school of "fuzzy logic" [YZ92], the prototypical problem of pattern recognition is highly related (e.g. [TK06]). Furthermore, *frontloading* has to be applicable on data sets of different coarse-graining.

2.3 Principal solution mechanism: aspect-oriented modelling

The requirements catalogue of the above two paragraphs shall now serve as the starting point for deriving a suitable modelling approach for *frontloading*.

First, the classical hierarchical modelling approach shall be considered. In this approach, a hypothetical comprehensive master model maps the technical state of the enterprise in its entirety by incorporating all different domain models. The model for a specific business incidence is, then, arrived at by omitting the irrelevant parts of the model. To be illustrative, let us consider the modelling of an incremental tariff change as a rather standard case in the Telco business. Then, in a first approximation, model domains such as 'technical network elements', or, 'product representation' can be dispensed with (note, that disruptive tariff changes may, in contrast, lead to drastic changes in the network usage so that the network needs to be modelled technically) and only a couple of domains such as 'market', 'finance & controlling' are retained. In the left-hand side of fig. 2 this modelling mechanism is schematically depicted. The arrows indicate the process of model construction for the considered specific case. When evaluating this approach, it is immediately clear that the procedural cost balance $A1 \sim A2$ shifts massively in disfavour of *frontloading* due to the unused parts of the model. The flexibility and adaptability demands of sections 2.1 and 2.2 can, evidently, not be met by this procedure. Furthermore, the master model as the basic prerequisite for this approach must remain elusive – in a large enterprise it is simply too costly to construct such a model and wholly unrealistic to keep it up to date.

The alternative approach on which the concept of frontloading hinges is of a 'constructivist' nature. This term is meant to describe the fundamental difference between passive omitting and active identification. Therefore, in the right-hand side of fig. 2, the model construction – characterized by the arrows – starts with a critical appraisal of the business incidence itself, i.e. the identification of the relevant principal enterprise domains. In a more formal informatics language, these domains are denoted as aspects, whence this modelling approach is called 'aspect-oriented modelling'. Whereas in the classical hierarchical modelling the omitting of domains is a severely restricted modelling activity, the dissecting of the considered business incidence into aspects is principally free and, therefore, creative structuring work.

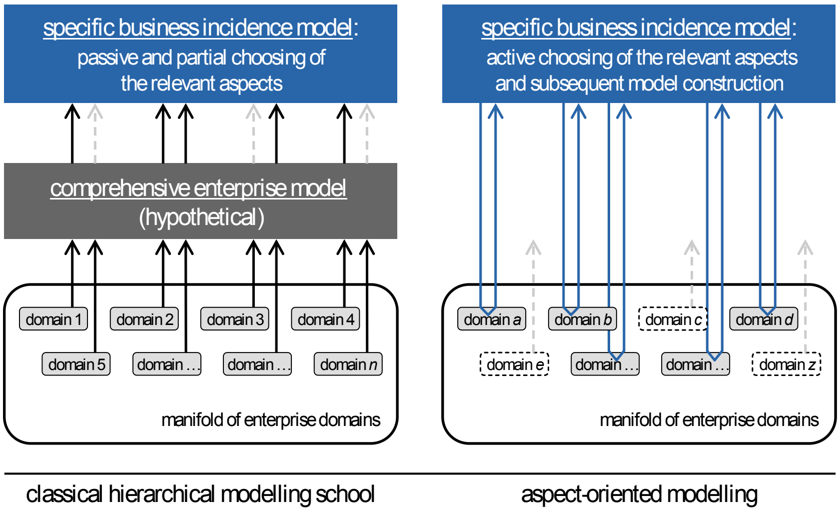

fig 2: The principles of aspect-oriented modelling (right-hand side): the model construction process (indicated by the arrows) starts with identifying the relevant aspects of the specific business incidence. A persistent master model with its enormous difficulties (maintenance efforts, comprehensiveness, responsibilities, up-to-dateness and so forth) can, thus, be dispensed with. Such a model would be necessary for the alternative classical approach which arrives at the specific model by the passive act of omitting irrelevant domains from it.

When evaluating the procedural costs of the aspect-oriented modelling approach (area *A1* in fig.1), it has to be acknowledged that the aspect identification itself creates additional cost. This, however, is overcompensated by the model comprehensiveness and maintenance costs associated with the left-hand side. Further costs of the right-hand side arise from the problematic reusability: as the aspects are free to choose, they may differ in consecutive applications (schematically in fig. 2: domains *1 ... n* on the left do not map exactly on domains *a ... z*). Furthermore, guidelines for aspect identification (topicality, granularity) are, purposefully, not given – the structuring of aspects is a first decisive, creative act. In practice, however, aspects will be related to roles in the enterprise processes. Since these roles are recurrent, so will be – in principle – the aspects. The constructivist approach of aspect-orientation corresponds, thus, to an active filtering; an overburdening of the model with irrelevant information is prevented.

Furthermore, the active choosing of model aspects is a very powerful mechanism for complexity reduction. The hypothetical technical master model depicted – for the sake of argument in fig.2 – will necessarily contain a number of inter-domain dependencies leading to a network-like complexity. It is characteristic for such a dependency structure that alterations are, potentially, not localized and cannot be gauged in an intuitive manner [MA99, Sch02]. The hypothesis in connection with aspect-oriented modelling is that a self-suggested identification of principal aspects corresponds to a decomposition of the network-like complexity into domains that are to a large extent decoupled. Then, the actual modelling work can be carried out in a quasi-linear fashion and the complexity is significantly reduced (see below fig. 3 – tree structure prevail below the aptly chosen principal aspects). It has to be reiterated, though, that the genuine complexity of the considered problem remains – how exactly this is done is shown below.

In a more detailed way, the benefit-cost ratio for the aspect-oriented modelling approach has to be discussed: only if the cost for constructing the specific model (effort, data capture, relationship identification) is less than the achieved benefit (risk control, dependency identification, overall project steering optimization), the approach can be deemed sensible. Two effects play in favour of this balance. First, the structuring work for complex projects needs to be carried out anyway. In contrast to phenomenological methods as e.g. Gantt diagrams or precedence diagrams (see [Mor97] for an overview), the method proposed here takes into account the nature of dependencies. In this sense, the capture of the required data and modelling of dependencies is not an extra effort to satisfy a tool but an early, coarse-grained version of indispensable structuring work. Second, with the complexity reduction argument from the paragraph above, quasi-linear domains will arise naturally from the aspect-oriented approach. Due to their weak outward coupling, these can effortlessly be reused in later tool applications. Thus, consecutive applications of the *frontloading* method lead to a growing, naturally structured knowledge base.

Finally, the differentiation level within the identified principal aspects is free to choose. Obviously, too little differentiation results in sub-critical complexity, so that no meaningful statements beyond the obvious may be derived. This acknowledged, the *frontloading* approach is adaptable to different states of maturity in the different aspects. With application at different times in the project lifecycle, different qualities of statements can be achieved. These qualities correspond to the different requirements of project steering.

When comparing the requirements catalogue of paragraphs 2.1 and 2.2 with the mechanisms of the aspect-oriented modelling approach as discussed here, the evident conclusion is that such an approach is well suited for the problem described. In the following, the principal solution elements are discussed.

3 Solution Elements

In the foregoing paragraph it has been argued that aspect-oriented modelling is the mechanism best suited to the empirical organizational and topical requirements. Starting from here, now actual representations of tool and method have to be derived:

- Representation: Aspect-oriented modelling as described above necessarily needs to start from a concrete given root node, the actual business incidence. From this root node, first-level branches lead to the principal aspects, these resulting from a first decisive analysis. Further differentiation into lower-level branches, then, takes place. The intuitive representation of such a hierarchical decomposition is a graphical one as in the well-known software *MindManager*; the so-called business map (see fig. 3). Obviously, very large business maps run into representation problems which can, however, be remedied by a variety of handling techniques.

- Reinsertion of nonlinearities: It has been clearly stated that no choice of aspects in the business map can remove the inherent complexity stemming from nonlinear coupling between different domains; at best, an intuitive ordering is possible. In fig. 3 the real systems exhibits nonlinear coupling: alterations in the domain "technology" will, for instance, directly effect the domain "product", but also via chains beginning with "IT", or, "marketing". The results of these feedback loops may be amplifying or conflicting – there is no intuitive way to tell. In the model system depicted below, these nonlinearities are, at first glance, lost by reformulating the dependencies as linear tree structures. As there holds a "conservation law" with respect to complexity, the nonlinear coupling has to be reinserted (in suggestive language, the linear model is "loaded" with the specific nonlinearities leading to the specific complexity of the considered business incidence). This is effected by assigning relationships to the end points of trees. For instance, in fig. 3 the product feature E bears a relation to the aspect "technology". The character of this relation is, in concordance with the generic adaptability property of aspect-oriented modelling, variable. It might be just a qualitative statement such as "depends on", or, "contributes to". Alternatively, it may be of explicit quantitative character – in the example of fig. 3, the product feature may depend arithmetically on the numerical value of a technical parameter specified in the "technology" domain. Reinserting nonlinear dependencies in such a constructivist manner leads to a rigorous slimming down of complexity.

- Sequence scenarios: The construction of a business map with filtered complexity described above yields, still, a static picture (map). For any assessment of project risks, or, for model-based decision support evaluation, however, a temporal resolution of the static map is needed. Within the chosen modelling approach, this is done by inserting the aspect "projects". This allows work packages to be connected with topical aspects. Nodes in the project domain, then, will gain or lose validity by temporal and functional targets which may be of a probabilistic nature. Thus, with probabilistic parameter variation scenarios may be calculated. The manifold of scenarios, then, forms the support basis for critical decisions to be taken by the project steering instance.

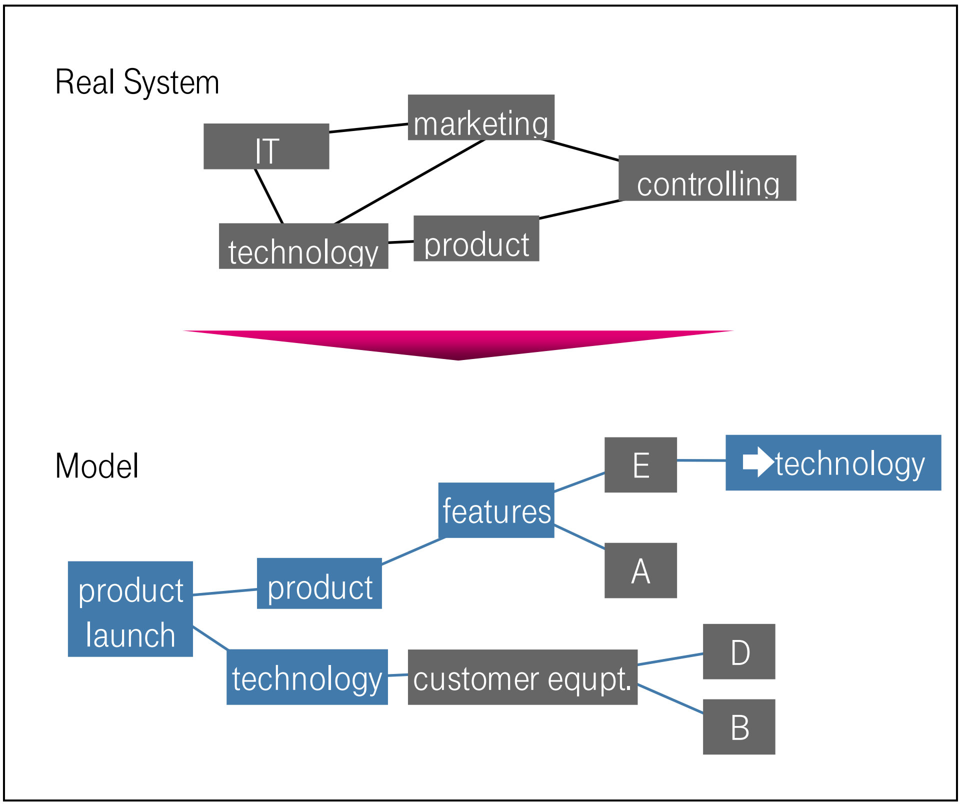

fig 3: Reformulating a nonlinear real system by the *frontloading* techniques: From a root node given by a concrete business incidence, principal aspects with subsequent linear sub-structures are identified and modelled. Complexity is reinserted by loading the end nodes with nonlinear relationships. This constructive prescription corresponds to a rigorous complexity filtering and results in a manageable model containing only the relevant set of dependencies.

The principal mechanisms and solution elements for the *frontloading* method and tool discussed here follow a common approach: the complexity of large-scale launch projects can be mastered in a simulative a priori modelling way if a constructivist approach is consequently pursued. The crucial adaptability and flexibility properties discussed above, then, follow in a natural way.

4 Summary and Outlook

Frontloading for Telco is not about a tool, it is not about processes, nor is it about master models or deterministic answers. Touching all these aspects, *frontloading* in the sense of this paper is about a concerted approach to understanding and structuring complex launch processes. The proposed method and the proposed tool are designed to incorporate maximum flexibility, and to infringe minimally upon existing processes and organization. At Deutsche Telekom, currently an R&D project is in its early stage testing the *frontloading* approach as developed here with real-life test cases.

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