STRATEGIC VISION OF THE EVOLUTION OF OSS (*)

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I. EXECUTIVE SUMMARY:

A fundamental restructuring of the telecommunications business coupled with operating and technological changes is resulting in a redefinition of the role, functionality and sophistication of Operations Support Systems (OSS). These are the information systems deployed in direct support of the management of the network, performing functions such as service provisioning, fault resolution, and quality monitoring.

The redefinition of the role and functionality of OSS is driven by three trends. First, on the business side, the convergence of networks and services, the multiplication of products and renewed emphasis on customer experience is impacting order management processes and service delivery. These two areas are greatly dependent on OSS to reduce time-to-market and improve service quality. Second, as a result of these trends and the need to control costs, carriers are engaged in transforming their operating models, which mean to change organization structures, simplify operational processes by breaking product silos, and outsourcing non-strategic functions. This transformation again puts pressure on OSS in terms of their degree of integration with Business Systems, and the need to move away from the "one system per product" philosophy. Finally, changes in technology and platforms is enabling the introduction of new services which, combined with personalization and customization capabilities, are putting pressure on business and operating systems. The compounded effect of these three trends is enhancing the strategic importance of OSS: they have become key enablers of the industry new model.

Having said that, managing the OSS architecture is confronting carriers with new challenges. First, the migration to convergent networks is resulting in an exponential increase in network elements, in terms of absolute number and types, which in turn drives structural complexity of applications such as automated fault management, service activation and others. Second, the need to reduce time-to-market in service introduction is affecting the OSS, in terms of limited scalability and congestion. Finally, at a time of entry of virtual operators, customer experience is becoming a key differentiator, and OSS become the critical lever to improve provisioning, repair and network performance.

Contrary to what occurred in the past, carriers now have choices as to how they design their OSS, and these choices have an impact on their ability to differentiate themselves in the market place. However, the growing complexity of the network infrastructure and the concurrent lack of a consolidated view of how OSS will support Next Generation Networks (NGN) is requiring carriers to carefully evaluate their options. Among the key issues to be addressed, operators need to define the target architecture for OSS in the context of NGN multi-product "all IP" networks. Having resolved this non-trivial issue, they must next define the transition path leading from the principles that guided the development of legacy applications to the future model. Yet, this needs to be done while retaining enough flexibility to manage the transition risk.

In this context, carriers need to tackle a series of key questions:

- What is the target architecture for OSS in the context of NGN multi-product "all IP" networks? In particular:

    - What is the role of the OSS in the development and operation of the new IMS/NGN based services?
    - How can the integration between OSS and BSS be improved?
- How will we guarantee sufficient flexibility in the target model to manage the proliferation of services yet to be defined?
- In defining the future model, how can we transition away from the principles and concepts that guided the development of legacy OSS? In particular:
    - What is the OSS roadmap considering the business needs and IMS/SDP impact?
    - How can redundancy between new OSS solutions and existing ones be avoided?
- Once defined, what is the roadmap that will allow carriers to transition from the current model fraught with legacy and ad-hoc integration modules to the target architecture? In this context, what will the plan be for retiring systems? How do we control for the migration risk?
- What is the role of "off-the shelf" systems within this target model?

The need to answer these critical questions points out to begin thinking about OSS strategically. Planning needs to be done proactively, abandoning the "service by service" silo mentality that is driven exclusively by short term needs. Furthermore, OSS planning cannot be delegated to an outside vendor. In conducting this process, service providers would benefit from following five best practices:

- Start by developing a common model and a roadmap; once this is done, make decisions about gradual retirement of legacy applications and potential purchasing of "off-the-shelf" packages
- Involve users and suppliers in the development of the model and allow for flexibility to deal with contingencies
- Look at the future building blocks and technology enablers in order to benefit from advancement in systems technology ranging from shared information models to flexible GUIs, and autonomic computing
- Proactively work with outside vendors in the development on an industry-wide approach aimed at achieving interoperability, production synergies and investment protection
- Build an internal technology assessment function that provides carriers with independence regarding industry developments. The internal function should contribute to planning the OSS model, provide vendor selection and customization services, and act as a vehicle for identifying new outside developments that could have a positive impact in the build-up of the new environment

The adoption of such practices will ensure that all transformational efforts conducted at the operational, network and systems levels result in quantum leap changes in performance.

II. INTRODUCTION:

The telecommunications industry is reaching the point where a number of transformational trends are simultaneously reaching the management agenda of service providers. The inventory of requirements range from adaptation to new commercial imperatives to dealing with new operating models while facing a major technological revolution exemplified by the migration to Next Generation Networks (NGN). In this context, the question is raised about the future of Operations

Support Systems (OSS), the set of information systems deployed in direct support of the management of the network performing functions such as service provisioning, fault resolution, and quality monitoring. Among the issues discussed in this paper are:

a. How are industry trends (business, operating and technological) going to affect the future of OSS?
b. How should we tackle the planning and managing of OSS? As an appendix to the network? Integrated with other systems?
c. How do migrate the current set of systems to those required by the future network?

This white paper has been developed based on research conducted with carriers in Europe and North America, surveying what is working, and what is not, attempting to distill some recommendations for the future planning and management of this critical component of the carriers' infrastructure**.**

III. INDUSTRY TRENDS AFFECTING THE FUTURE OF OSS:

Operations Support Systems are undergoing a fundamental redefinition of their role and importance driven by changes in the telecommunications business, transformation of the carriers operating model and technological evolution. We will review each of these three areas in turn.

III.1. Changes in Industry Dynamics:

Changes in the telecommunications industry are having a dramatic impact on OSS, and are leading service providers to start putting a lot more attention on planning and managing of this portion of the systems architecture. Theses changes are of two types:

- Convergence of networks and services
- Multiplication of products and services

III.I.1. Convergence of networks and services:

Almost all carriers in the industry today are deploying convergent strategies. To begin with, incumbent players (such as AT&T, Deutsche Telekom, Telefonica, KPN) are becoming vertically and horizontally integrated. Their objectives are aimed at delivering not only bundles of services, from fixed to mobile telephony, broadband and entertainment services, but also a new set of services developed by means of integrating multiple technology platforms. In addition, they are attempting to leverage new economies of scale and scope and reduce in-house transaction costs.

Beyond the incumbent carriers, cable TV operators competing with the telecommunications operators are also aiming at delivering similar value propositions. Even "pure play" operators, like Vodafone and Sprint-Nextel, have entered the fray of triple and quad-play, through either strategic partnerships or new technology platforms.

The convergence of telecommunications businesses is driving the standardization of processes between business units, which in turn result in the convergence of systems that support and automate

them. This trend has a direct impact on OSS since they are supposed to support multiple network platforms.

III.1.2. Multiplication of products and services:

After the intense high-paced growth experienced since the early 90s, first fueled by wireless and then by broadband, the telecommunications industry is entering a period of maturation, characterized however by an ever-increasing growth in traffic and the need to introduce new services to neutralize the reduction of prices. With the exception of emerging economies, wireless services have reached full penetration. The remaining segments to be penetrated are low-income portions of the socio-demographic pyramid, immigrants and young children. At this point, future growth in wireless will be fueled by new data services beyond SMS. In search for new revenues, all wireless carriers are incessantly launching new services aimed at growing ARPU. While broadband has not reached comparable levels of penetration in all industrialized countries, growth of broadband is slowing down significantly in Korea, Japan and the United States. We expect that other European countries will reach comparable situations within the next three years.

Under the prospect of slowing industry growth, the competitive intensity will increase. With prices that have significantly reduced in the past ten years, competition will materialize in product innovation and improvement of the customer experience. Product innovation is triggering the launch of new products and services. In this context, the evolution of the new access networks becomes the key enabler of the development of new services. This effect is requiring carriers to improve their product development and launch processes and reduce their time to market. Some carriers are aiming at defining time-to-market objectives of 60 days. However, a worldwide survey of 100 telecommunications carriers indicated that only 34% could introduce new services in less than six months, with most new service introduction timing ranging from six to eighteen months. As a consequence, 70% of wireline carriers said that the speed of service creation represented their biggest challenge[1].

The improvement of customer experience is aimed at reinforcing customer loyalty and increasing the chances of capturing a larger share of wallet of existing customers. This challenge is non-discretionary. Escalating user sophistication could result in gradual deterioration of customer satisfaction and, consequently, increase in churn. Maturation of wireless services results in increasing user sophistication and heightened expectations. This impacts not only the way customers shop and behave but also how business operations are managed. Shortening of product life cycle makes carriers less adept at keeping up with user expectations and knowledge (What happens when the customer knows more than the staff?).

The principal challenge on the customer experience has been found to be on the order management process. Carriers are seeking to migrate customer management processes, particularly order management to a single, streamlined process, which is expected to impact their ability to effectively manage their bundled offerings.

[1] Coleman Parkes. *Transforming Operations Support Systems: Trends, Issues and Priorities of Communications Service Providers*. February 2007.

These two trends, reduction in time-to-market and improvement of customer experience, put significant pressure on OSS. Adding new services represents increasing the range of tasks to be fulfilled not only in terms of provisioning, but also with regards of monitoring network quality. If these new requirements are not met, revenues do not materialize and/or customer experience might be affected. As a result, the OSS become a significant bottleneck in the carrier's transformation process.

III.2. Changes in the operating model:

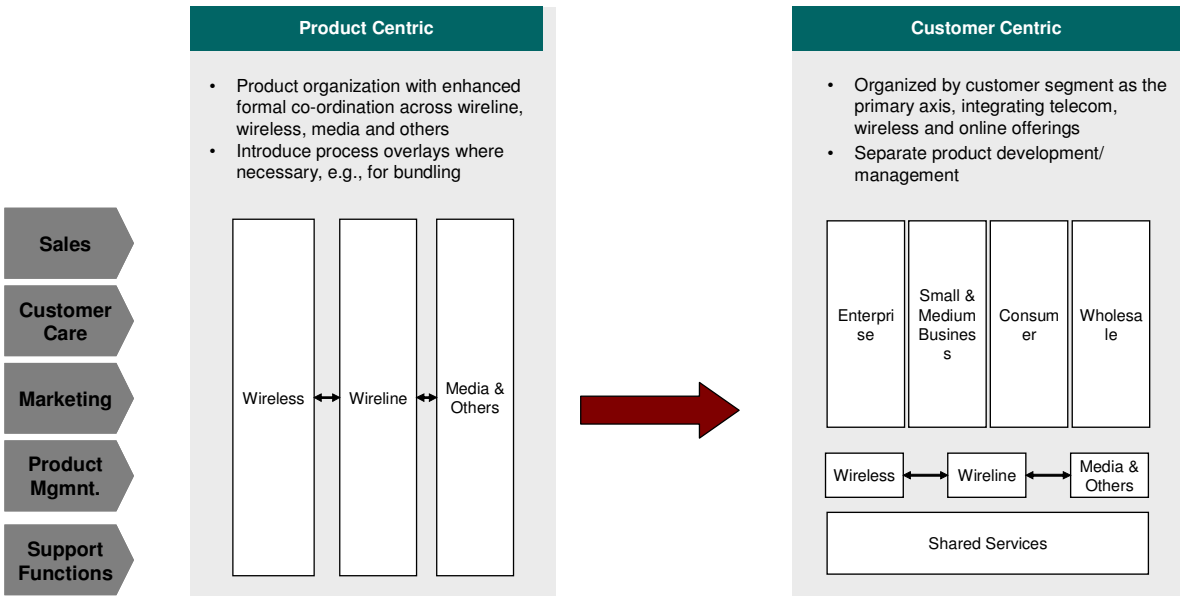
The changes in industry dynamics reviewed above are driving the need to transform the carriers' operating model. We visualize the transformation of the operating model to proceed along three paths: first, organizational convergence around business units serving specific customer segments with wireless, fixed and data products; second, the simplification of operational processes by breaking the product silos; and, third, outsourcing of non-strategic functions.

III.2.1. Customer-centric models:

To tackle the convergence challenge, service providers have begun a process aimed at transforming their organizations, business processes, and management and information systems. At the organizational level, carriers are beginning to migrate from a product centric to a customer centric operating model. Product centric models, in the traditional carrier organization, are based on product based business units (fixed telephony, wireless, media and online services). To enable these models to support convergent services, management has had to build formal coordination mechanisms across business units, and introduce process overlays, where necessary. However, these organizations are proving to be too cumbersome, exhibiting unusually long cycle times for launching new service offers.

The natural response chosen by many organizations has been the migration to customer-centric models, whereby the market-facing business units are not structured by product (fixed telephony, mobile, etc.), but by market segment (enterprise, small and medium enterprise, residential, etc.) (See exhibit 1).

Exhibit 1: Alternative Organization Models



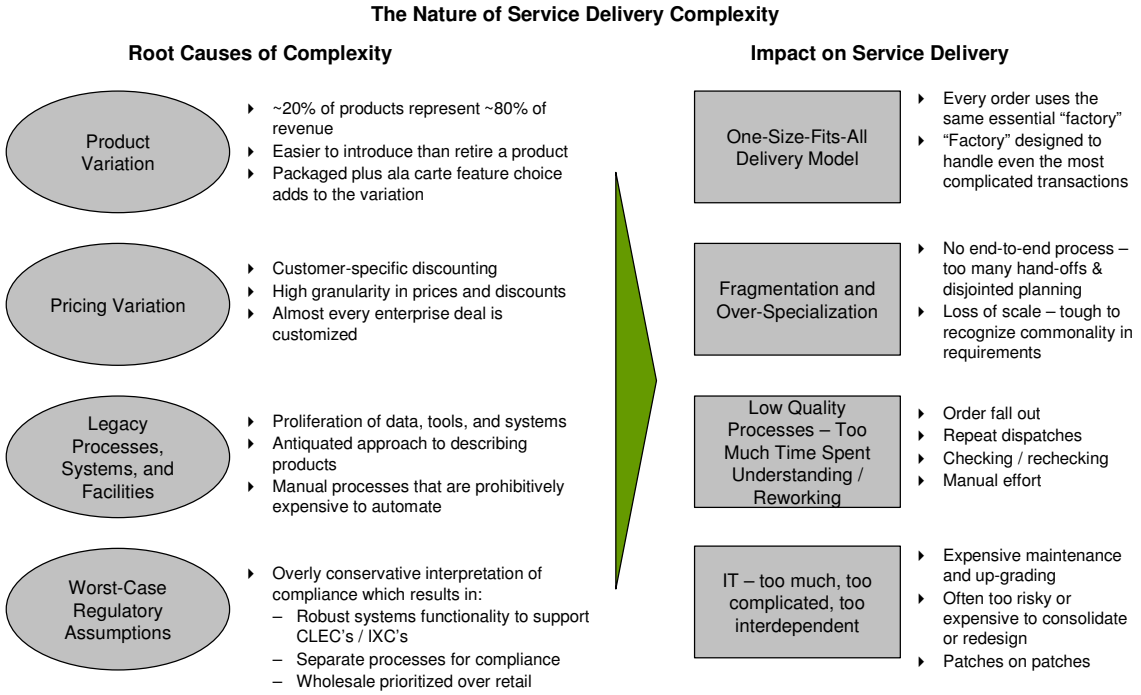
This migration is being instrumental in breaking the product silos and building and integrated customer segment focus view (i.e. what do customer segments want? How do we serve them appropriately? How do we meet their needs for product bundling?)

Customer-centric models are key in growing revenues and consolidating lifetime loyalty. These operating models are particularly adept at developing integrated offerings that allow carriers to capture a higher share of the total telecom spend and lowering customer churn. Furthermore the cross-marketing and management of the customer base allows for higher retention and better alignment of products and markets.

On the other hand, while the customer centric model provides the highest revenue potential in terms of capturing the largest share of communications spending of a household or an enterprise, its level of complexity makes it difficult to implement. Among the complexity issues, one should mention the coordination of market facing units and product organizations to avoid conflict and the need for market facing functions to support multiple product lines. Similarly, customer centric units present the greatest disruption to product-centric organizations, in terms of cultural change and migration risk.

III.2.2. The need to simplify operations:

Operations of most service providers present challenges related to the complexity of its operations. Operational complexity results from building specific processes, systems and resources for each product, reinforcing a silo-based approach. Product specific processes lead to worst case assumptions about upstream operating performance and variability (for example, extra just-in-case capacity or complex process flows to accommodate the unknown). The resulting environment presents a set of challenges to carriers operations (see exhibit 2):



In the end, the service delivery streams of carriers tend to exhibit numerous dysfunctional ties across the value chain:

- Provisioning, customer care and billing: high level of variability in processing time due to uneven quality of operations and difficulty in diagnose and resolve failures. This leads to low agent utilization and problems in leveraging processing economies of scale
- Network operations: design and configuration of network equipment to support specific products leading to unstable and difficult to forecast requirements, which has an impact on network planning and engineering, deployment of O&M teams and time spent in managing inventory. Ultimately, this situation results in high equipment costs and staff increases in network engineering and management of suppliers
- Marketing and product management: great variety of products in terms of options, combinations, packaging and unlimited number of price plans and tariffs. For example, we have surveyed incumbent carriers with a total product range reaching 20,000. Product multiplication results in complexity in management of downstream processes, such as pricing policy as well as negative impact on network and operations.

In this context, carriers are engaged in attempting to simplify the operating model by virtue of attacking the most difficult part of carrier operations: processes. Simplification of processes is being achieved by virtue of implementing common processes for routine operations across products and breaking down the product related silos. This means conducting an overall assessment of operational processes aimed at identifying the routine, repetitive, basic and stable streams and differentiating them from the customized processes that are specific to a product. In our experience, common, undifferentiated processes (e.g. opening a customer account) amount to 80% of all activities. Once these are identified, operational flows are standardized across products, which allow to better managing utilization and capacity peaks. The operational environment would still need to accommodate for product specific routines as well as exception handling (the remaining 20% of processes).

This transformation, while complex, is extremely useful in terms of generating cost savings amounting to approximately 30% of costs[2]. Having said that, the degree of transformation is quite high and risky, which keeps many carriers from tackling it.

III.2.3. Outsourcing of non-strategic functions:

Outsourcing of operating functions in the telecommunications industry is becoming quite pervasive as indicated by our research among operators. In fact, many carriers around the world have outsourced (or are considering outsourcing) many operating functions. However, according to a survey among carriers in North America and Europe, there appears to be almost universal consensus that planning has to remain an internal function (see exhibit 3).

[2] According to the experience of an ILEC in North America.

Exhibit 3. Outsourcing opportunities along the value chain

	NETWORK	IT	PRODUCTS	CRM AND BILLING	MARKETING AND SALES
PLAN DESIGN		Architecture design & vendor selection	Product & service definition	Customer segmentation service level definition	Pricing
			Service delivery platform development	Billing requirement specification	Branding
	Network planning and architecture	Product systems management			Channel management
OPERATE	Network tuning & optimization	Software development	Service delivery platform operations	Billing mediation	Advertising
	Network operations	Applications operations core systems	Content bundling	Billing operations	Points of sale
	Network maintenance		Solution provisioning	Call center operations (inbound)	
			Application and content development		
	Infrastructure installation	IT Operations	Application operations	Telemarketing	Logistics
		IT Infrastructure/data center		Bill printing, distribution	
		Applications operations support systems			

Source: Booz Allen Hamilton, based on interviews of 20+ carriers in Europe and North America

	Generally outsourced or under consideration		Kept in-house
	Outsourced considered in mid-term future		Delivered in partnerships

A particular comment is worth making when it comes to IT outsourcing. Outsourcing of IT, while extremely popular these days, presents some shortfalls that need to be addressed. The economic value proposition of outsourcing or purchasing "off-the shelf" systems is based on the premise that this approach is significantly less expensive than in-house development (a rule of thumb in this case is that outsourcing should at least yield a 15% cost reduction). In this context, economic theory stipulates that evaluation of the outsourcing economics need to comprise not only the charges of the outside vendor (one-time and recurrent) but also the transaction costs incurred in having to integrate the vendor with the organization in terms of processes (monitoring quality) and systems (customization of interfaces). As such, in the case of OSS, if the components being outsourced or purchased in the open market do not have a standardized set of APIs and data elements, the customization costs will in most cases neutralize the advantage of purchasing the solution in the open market. This problem can be further aggravated by "time and materials" billing approaches

which amount to a blank check the operator extends to the outside vendor (more man/hours lead to more lines of code, resulting in increased complexity).

Furthermore, the definition of standards remains critical if IT outsourcing is to be considered. Before the industry deregulated and telcos were operating under monopolistic market conditions, standards were less important in the sense that OSS development was defined based on input of only two parties: the operator and the supplier of network equipment. Standards and migration roadmaps were charted based on the release of software generics led by the equipment manufacturer. With industry deregulation, the number of buyers grew dramatically. Similarly, the fragmentation of the equipment manufacturing value chain signaled the emergence of multiple software providers, each competing with alternative solutions. In this context, standards applied to complementary software assets have become very important at this point to ensure that operators can avoid the customization trap. It should be noted that other carriers might chose a "best-of-suite" approach with the objective of minimizing customization costs. However, we believe that a "suite" strategy will still not have a positive impact on customization costs at the OSS level (it might only reduce customization costs within Billing, CRM, Finance and other BSS modules).

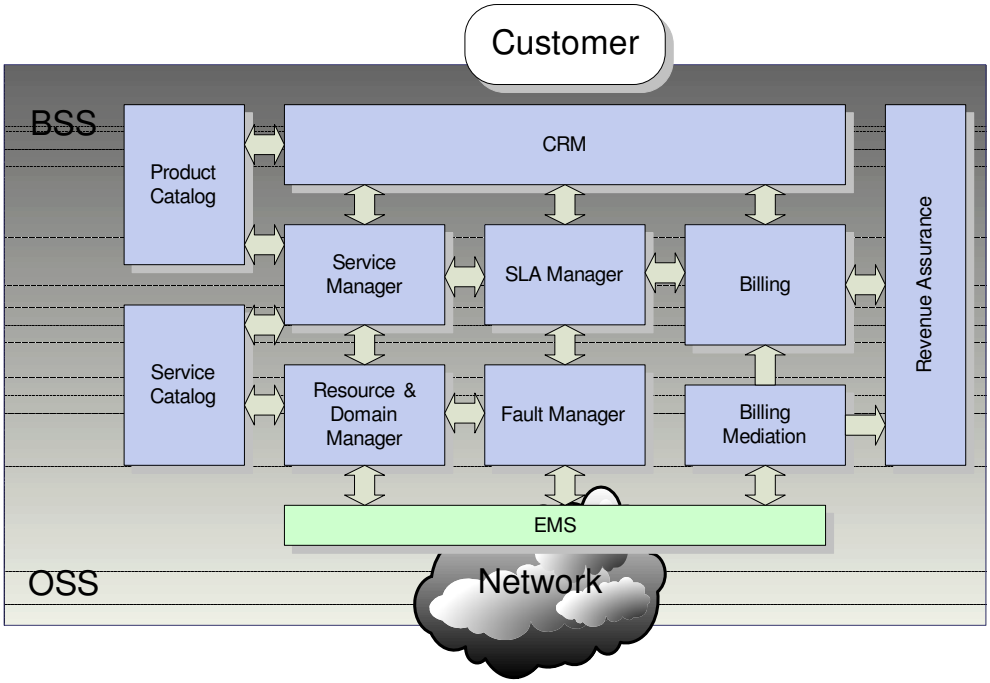
III.3. Changes in Technology and Platforms:

The telecommunications network is facing exponentially growing complexity. New types of handsets and end-user devices (PCs, PDAs, iPhone), new access infrastructures (XDSL, FTTX, WiFi, UMTS, LTE) and IMS are some of the new technologies being introduced in the network nowadays. In parallel, new services, combined with personalization and customization (cloud computing, SaaS, and P2P), are putting pressure on business systems. The growing network and service complexity makes the operation and maintenance of the network more and more costly at a time when cost reduction remains a critical business imperative.

Contrary to what occurred years ago, OSS have now a strategic importance in building an efficient platform for delivery of telecommunications services. Until recently, OSS had been considered the after thought in developing technology strategies for service providers. This was the result of two premises: first, competitive differentiation and advantage was driven by the systems supporting primary customer contact (e.g. billing, customer care, etc.) rather than those that optimized delivery of service; second, age-old control of OSS by network equipment manufacturers rendered provisioning of OSS a process controlled by outside suppliers rather than the carriers.

These two trends have been changing in the past five years. First, the boundary between Business Support Systems and Operations Support Systems has become increasingly blurred (see exhibit 4).

Exhibit 4. OSS/BSS Modularity and Integration



Customer processes are being managed on an end-to-end basis, which means that sales, provisioning, and after sales care are interlinked, rendering the boundary between CRM and Provisioning as well as Network Quality artificial. This means that the traditional boundary that assimilated BSS to IT and OSS to Network Operations is increasingly contested.

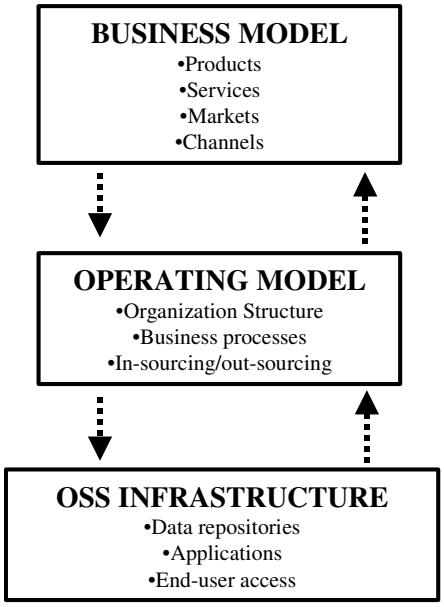
Second, the migration to all IP network platforms has allowed the industry to drive a wedge between Operations Systems and Network Operations. Contrary to what occurred in the past, carriers now have choices as to how they design their OSS and what vendors do they choose. Having a control of their own destiny in this domain has been forcing them to pay more attention at the direction they take.

IV. IMPACT OF INDUSTRY TRENDS ON OSS:

The compounded effect of the three trends reviewed above is enhancing the strategic importance of OSS. This importance can be conceptualized in two ways: first, industry trends are changing the OSS landscape relative to what they used to be in the past[3], and second, the OSS become a key enabler of the industry new model (see exhibit 5).

[3] See Edwards, R. *History and Status of OSS*, Journal of Network and Systems Management (December 2007), 15:555-567.

Exhibit 5: Strategic Importance of OSS



When it comes to information systems, the migration to customer-centric operating models puts pressure on telecommunications carriers to move rapidly to highly integrated architectures, comprising common systems and business processes (rather than product-centric stove-pipe applications and processes), and harmonized customer data elements across systems. Because of the blurring of boundaries between BSS and OSS, integration spans all functional areas of the architecture, from billing to provisioning, from customer relationship management to quality management and logistics. Having said that, integration is not easy. In fact, it is complex, costly and risky.

Integration that fails to support the hand-off of critical processes leads to errors and delays, with the consequent degradation of the customer experience. This can allow revenue to slip through the cracks and compound the time and investment required to bring new services to market. The importance of OSS in enhancing the customer experience is particularly important in installation and post-sales service.

In addition to streamline order management processes mentioned above, carriers engaged in launching convergent services needed to migrate a large portion of development resources to "true innovation" initiatives. Typically, service providers spend on average 6.5% of their revenues on Information Technology (IT); this percentage is comprised of both capital and operating expenditures in any given year. A large portion of this amount (approximately 60%) is being spent on activities oriented to simply maintain the operating status quo (i.e. "keeping the lights on")[4]. This is primarily due to the complexity of existing system architectures derived from either legacy

[4] Katz, R.L. and Pereira J. *Assessing TCO for best of suite versus best-of-breed architectures in the telecommunications service industries*. July 2007

systems or based on strictly implemented Best-of-Breed approaches. These require service providers to allocate an inordinate amount of resources to dealing with an unusually large number of systems and their interfaces. In addition to the resource burden, architectural complexity is also increasingly becoming a barrier to launch new products on time and deal with key challenges, such as improving the customer experience. Total cost of ownership needs to be reduced, while more resources need to be focused on efficiently managing and growing the business. In that sense, the objective is to shift percent of resources assigned to new business initiatives in the range of 50% to 70% of total IT costs.

In addition, the migration to convergent networks is resulting in an exponential increase in network elements (in terms of number of platforms, types, and even the inclusion of customer premise equipment), which in turn results in growing complexity of OSS processes. The introduction of agents linked to new network elements associated to convergent networks raises the systems structural complexity of OSS such as automated fault management, service activation and others. The problem is even more acute since in many cases, legacy OSS have been designed to support fixed voice telephony services and lack the flexibility to accommodate convergent services. Furthermore, while there is already a common need to evolve the OSS to meet the requirements of NGN/IMS networks, there is not yet in the industry a consolidated view of IMS, SDP and OSS roles.

Furthermore, the reduction in time-to-market challenge is putting increasing pressure on IT departments. Some carriers are aiming at cutting system development cycle times to between 60 and 30 days. This is compounded by the multiplicity of products and services. The rhythm at which new products are being introduced is affecting the OSS architecture, particularly in the areas of fulfillment, diagnostic, quality monitoring, and inventory. The symptoms of negative impact are limited scalability, congestion, and structural complexity.

Finally, at a time of entry of virtual operators relying on incumbent carriers' unbundled loops, customer experience is becoming a key differentiator, and OSS are becoming a critical lever in driving differentiation[5]. For example, OSS have a direct impact on provisioning (mean-time to-installation), fault management (mean-time-to-repair), quality of service management and network performance.

To sum up, changes in the business are driving the need to put more focus on the management of the OSS architecture. If carriers do not apply long term planning techniques and proactive architectural management rules to this section of IT, this could become the next bottleneck in the growth of the telecommunications industry.

V. NEED TO DEVELOP A STRATEGIC VISION IN PLANNING FOR THE OSS:

Despite the growing importance of OSS, this does not always lead to increased focus and attention in the strategic planning processes of operators. This lack of emphasis and attention of OSS in strategic planning processes is also mirrored in the limited attention put by senior management of several operators on the OSS function itself. In many cases, OSS are assimilated to other cost items of the infrastructure. As such, their treatment in the strategic planning process is more akin to an

[5] Also called "Soft Telcos", these service-centric carriers focus exclusively on delivery to focused markets, avoiding the need to invest in physical access infrastructure.

undifferentiated item in the capital planning process where investment decisions are not guided by strategic business imperatives (should we invest? How much? What is their priority relative to other items?)

The problem with this approach is that it does not tackle what we believe to be the fundamental future problems of network management systems:

- What is the target architecture for OSS in the context of NGN multi-product "all IP" networks? In particular:
  - What is the role of the OSS in the development and operation of the new IMS/NGN based services?
  - How can the integration between OSS and BSS be improved?
- How will we guarantee sufficient flexibility in the target model to manage the proliferation of services yet to be defined?
- In defining the future model, how can we transition away from the principles and concepts that guided the development of legacy OSS? In particular:
  - What is the OSS roadmap considering the business needs and IMS/SDP impact?
  - How can redundancy between new OSS solutions and existing ones be avoided?
- Once defined, what is the roadmap that will allow carriers to transition from the current model fraught with legacy and ad-hoc integration modules to the target architecture? In this context, what will the plan be for retiring systems? How do we control for the migration risk?
- What is the role of "off-the shelf" systems within this target model?

In parallel with addressing these fundamental questions, the industry needs to determine how to respond to daily needs from the business. In fact, service providers cannot wait until the future model is defined. Convergence, competitive intensity and customer centricity are present day trends requiring answers today. So the challenge is two-fold: respond to today's imperatives, while addressing the transition to the future model. Our research among service providers indicates that, while many are in the process of tackling some of these issues at the BSS level, it is rare the case when they are being addressed for OSS. In fact, while 70% of 100 wireline and wireless carriers surveyed in the research cited above indicated that OSS transformation is essential for new service introduction, many continue taking a "service-by-service" approach to fulfillment to meet the demand's of today's market. This approach continues to perpetuate the fragmentation of data in the OSS. At a more fundamental level, while most carriers tend to think of the strategic need to transform the OSS to deal with business imperatives, they tend to address the operational issues tactically.

In general terms, the experience of operators regarding the strategic planning of OSS can be categorized around three different approaches:

- **Proactive planning:** some operators have taken a very "hands-on" approach in the determination of the future OSS architecture. This approach is holistic, integrated with network and BSS planning, and linked to the requirements of the business. Under this approach, some carriers have created a technology assessment and strategy function within their IT unit. This function assumes responsibilities for designing an OSS architectural roadmap for the Next Generation Network. This architecture comprises an interface layer

developed in-house based on open source software, and serves as an interface to any off-the-shelf OSS the carrier might purchase. Some portions of the development could be outsourced but all design decisions are controlled within the carrier

- **Incremental piece-meal planning:** other operators believe planning equates with the incremental determination of solutions as a function of the short-term needs of the business. This type of approach focuses on the tactical requirements (e.g. need to launch a new product), which trigger installation of new applications. As such, this philosophy lacks the integrated dimension pointed in the proactive approach described above. This could be directly explained by shortfalls in the long term planning process. For example:

  a. Lack of integrated planning
  b. Lack of systematic analysis of how technological improvements can be incorporated in the systems architecture
  c. Lack of separation between strategic planning and systems operations, which leaves the IT function incapable of dealing with matters other than the day-to-day
  d. Organizational separation between OSS and the rest of the IT function, which impedes an integrated planning process and drives redundant efforts and prevents an end-to-end vision of processes being supported

- **Planning outsourcing:** this approach pre-supposes the subcontracting of OSS planning to an outside supplier (i.e. an independent systems vendor). Facing the complexity of requirements and migration, some operators implicitly delegate that responsibility to a vendor, therefore linking internal OSS planning to the supplier product plan

Each approach results in a specific philosophy regarding to the development of an internal technology assessment and planning capability for OSS:

- Proactive capability: build-up of developed/sophisticated technology assessment and planning capability
- Incremental piece-meal planning: rely of a reduced technology assessment and planning function to explore point solutions for specific applications
- Planning outsourcing: no technology assessment and planning capability at all, relying on an outside vendor partner

VI. PRESCRIPTIONS TO OPERATORS:

The analysis of the situation presented above leads to develop a set of recommendations on how telecommunications carriers should conduct the planning and management of their OSS.

1. ***Develop a model and a roadmap:*** Operators need to define an OSS model were they take control of their ultimate destiny: do not outsource strategic planning of the OSS architecture. The common model supporting a unified network should include a high level architecture, an applications map, an evolution roadmap, the SOA initiatives and catalogs of management components and services based on commercial products and contrasted solutions in every functional area. Operators are responsible for defining the overall architecture, modules and

standards. Once these are defined, they can make outsourcing decisions or off-the-shelf purchasing. The roadmap needs to be defined incrementally allowing for the gradual retirement of legacy applications without exposing the carrier to undue transformation risk.

When planning for the future architecture, user and technology supplier participation is critical. Furthermore, since it impossible to anticipate all future requirements of the business, architectures and systems need to be designed with flexibility in mind

2. ***Look at the future building blocks and technology enablers:*** Operators need to systematically incorporate new technological developments. While most operators are still using isolated, monolithic, multi-function OSS, systems technology has developed significantly in recent years, which has yielded a widely accepted new generation of OSS, emphasizing operational efficiency through flexibility. The distinctive characteristic of the new generation is its process orientation, where individual systems conform an architecture of co-working and co-evolving solutions. It is based on a set of commonly accepted technologies that can be utilized to support automation and optimization of business processes. They range from Service Oriented Architectures (SOA) to Shared Information Models and flexible GUIs. SOAs allow for flexible definition of processes, which flow through organizational boundaries, becoming a key enabler to the simplification trend reviewed above. Shared Information Models provide a common concepts layer, while flexible, self-configuration GUIs integrate human knowledge into the information systems. This will allow carriers to incorporate the knowledge and manage end user experience. Based on a new development paradigm allowing users to speed up the product development process, end users are integrated in applications development, configuring and constructing solutions in a self-service mode, according to their needs and leveraging a common set of resources, from catalogs to data definition files, to development tools. This Knowledge-Based Operations Support environment has a positive impact on product development (reducing time-to-market), end-user productivity and process automation.

   Looking beyond the current generation of improvements, technology is already generating the building blocks of the next one that will integrate previous generations of OSS into a more autonomous and intelligent environment. Intelligent adaptive and autonomic agents realize common, repetitive low-level tasks providing a self-management capability to the software and hardware infrastructures that support service delivery (autonomic computing and communications allowing the self managed telco network). Complementing this autonomic capability, carriers should increasingly rely on probabilistic management to handle quality monitoring in increasingly complex networks[6].

   Finally, ontology based information models provide the common language for a completely distributed shared information model. Policies will guide the aggregated high behavior of the system, which will exhibit emergent properties that can be understood. Rich information and

[6] See Vadi, Y. *Deduction of Network behaviour from a statistical estimation of the analysed traffic*, and Adhikari, A., Denby, L., Landwehr, J, and Meloche, J. (Data Analysis Research Dept, Avaya Labs) *Using Data Network Metrics with Graphics on the Topology to Explore Network Characteristics* (paper submitted at DIMACS Workshop on Complex Datasets and Inverse Problems: Tomography, Networks, and Beyond: A Conference in Memory of Yehuda Vardi, October 21 - 22, 2005)

flexible information rich searches will allow for the emergence of a creative knowledge environment. This environment will result in a change in the systems development paradigm from "closed" applications based on requirements to flexible resource search, shared knowledge between users and carriers, and automatic identification of processes susceptible of be automated. Based on these elements, human and machine experience and reasoning is distributed and incorporated into the shared information model.

In searching for technology enablers, carriers should keep open the possibility to incorporate experience from outside the enterprise. Outside industry groups[7] have been tackling some of the systems bottlenecks and lack of standards. Some operators have begun to incorporate these technological developments in the planning of their OSS architecture. Others, however, have been slower in achieving this assimilation.

3. ***Develop an industry-wide approach aimed at working with outside vendors:*** Historically, Commercial Off the Shelf OSS have been developed in temporal and process silos. This has resulted in a situation where each ISV has developed their own view of a product model, often misaligned with that one of the carriers. Furthermore, the "off-the-shelf" products restrict their data model to their functional area, with no industry API standard for data synchronization.

   Operators need to link up in order to define the industry-wide standards that vendors need to abide by in the development of their products[8]. As such, the objective is to render interoperable the technology offered by outside suppliers. Interoperability will help carriers build production synergies and protect the investment in "off-the-shelf" packages. The carriers need to help defining open standards and publicly available specs.

4. ***Build an internal technology assessment capability that provides carriers with independence regarding the industry developments:*** This capability should be responsible of multiple activities:

   a. Identify technology trends to be integrated in the future OSS architecture
   b. Have a capability to contribute to OSS planning and standards definition by providing the strategic vision for the definition of the common model for OSS
   c. Provide customization services for integration in those areas where standards have not been specified. Those services have to be provided within a framework that avoids the transaction costs of dealing with an outside vendor
   d. Provide high level consulting in solutions, applications and tools for OSS construction
   e. Become a vehicle for enabling the achievement of synergies in the development of common OSS platforms by promoting exchange of knowledge and best practices within the carrier

[7] Among these, we should mention the TeleManagement Forum (eTOM, NGOSS, Shared Information/Data Model), Parlay Consortium (OSA/Parlay), Distributed Management Task Force (Common Information Model), IETF (Common Open Policy Service Protocol, LDAP), ETSI TISPAN (telecommunications and Internet Converged Services and Protocols for Advanced Networking)

[8] Models such as the TMF PSA Catalyst project by BT, Cable & Wireless, TeliaSonera, Qinetiq, Axiom, Atos-Origin, Convergys, Huawei, Oracle and Tibco that developed the Active Catalogue concept are very relevant.

f. Development of leading edge technologies that lead to build up of competitive advantage without “reinventing the wheel”

VII. CONCLUSIONS:

To conclude, we have reviewed how changes in the telecommunications industry which are triggering transformations in the operating model of carriers, are raising some fundamental questions on the future role of OSS. These questions result in the need to begin considering OSS as a key strategic asset in the future carrier infrastructure. Given their strategic nature, it becomes imperative that carriers start planning for investment and deployment of OSS in a different way from what they have been doing until now. We have prescribed what we believe to be a set of best practices we have identified in certain carriers around the industrialized world. The adoption of such practices will ensure that all transformational efforts conducted at the operational, network and systems level result in quantum leap changes in performance.

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