Flexible Service Creation: IN/AIN -> NGN -> IMS - *Déjà vu* All Over Again?

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1. Executive Summary:

The Telecommunications industry has struggled with the challenges of rapid flexible service creation and introduction for several decades. The themes being sounded today regarding the emerging IMS architecture bear striking similarity to conversations and expectations from the AIN era. This paper reviews earlier experience and then analyzes the potential of the IMS architecture to materially impact future service creation efforts and to guide the realization of that potential. Major conclusions that follow from this analysis are:

- A key advantage IMS brings is its provision of a detailed coherent model for converged and intelligent services, the absence of which fundamentally hampered NGN.
- The IMS architecture meaningfully incorporates wireless access and concentrates service information in the HSS, laying the groundwork for better feature interaction and service management. Convergent services push the envelope for feature/service interworking. The IMS architecture has mechanisms incorporated into it that can support both straightforward and complex feature interactions.
- The complexity of this architecture, the continued lack of service creation standards, the prevalence of SIP Extensions, the challenges of multi-component ("best-of-breed") integration and the pressure to "be here now" will drive "pre-IMS" offerings with Service Provider dependence in general on a single supplier that has perhaps partnered for certain components in some specific product areas.
- The complexity of converged services does not bode well for the identification of "golden" services with sufficient penetration and associated revenue to make their economics attractive. Such services are unlikely to drive investment per se in this technology.
- Services that engage third-party components will have even greater challenges from a business perspective, implying that IMS will not cause the long-forecasted Applications Marketplace to emerge.
- Given the current architecture and product maturity, Operations will continue to be addressed in an ad-hoc manner by Service Providers, integrating the needed capabilities into their existing OSS infrastructure in concert with product-specific managers.

2. Back to the Future: AIN Promise in the 1995 Time Frame:

By 1995, the first significant AIN technology deployments had started and there was considerable excitement and expectation regarding the proliferation of new services and the revenue they would generate. AIN advocates expected some important objectives to be met by the emerging technology, including 1) Rapid Service Development and Deployment; 2) Vendor Independence; 3) Significant Cost Advantages; 4) Easy Service Customization; 5) an Applications Marketplace; and 6) a Broad Set of Applications Developers using a core set of atomic Service Independent Building Blocks (SIBBs). [1] Less frequently stated but nevertheless expected was that such offerings would be scalable, allowing prototype solutions to be broadly deployed in a straightforward manner.

AIN technology was primarily SS7-oriented. [2] The architecture centered on Service Switching Point (SSP) functionality in the Class 5 or Local Switching Office; Service Control Points (SCPs) connected to the SSPs via the Signaling System 7 Network; with triggers in the SSP activated on a per line basis that launched queries to the SCPs and received information or control responses associated with the service being supported. There was a coherent detailed Call Model that prescribed the points in a call where AIN (SSP-SCP) interactions could arise. Depending on the service involved, the SCP could function as a database repository (in many ways, more like an LDAP server in a NGN architecture) and/or as the host for subscriber-specific data (comparable to the HSS in the IMS architecture) and associated service logic for call processing.

There was also use of Intelligent Peripherals/Service Nodes (IP/SNs) with roles that ranged from functioning as a "dumb" resource server (i.e., controlled by the SCPs) to systems that supported comparable service creation to that of the Service Control Points. The latter full-function Service Nodes terminated calls, with intelligent call processing contained within the device and in some more interesting applications, SN-SCP communication and service coordination. The differences in use of the IP/SNs here reflected

fundamentally different choices for the location of service control and the distribution of intelligence. These differences directly affected the complexity and the cost of the services supported in this architecture.
The AIN story gets mixed reviews when people assess how well it met its objectives.[1, 3, 4] There was considerable industry hype regarding the technology during its infancy, setting expectations that proved to be unrealistic. On the other hand, significant service development and deployment were accomplished using the AIN architecture. It is worthwhile to understand both the promises met and the disappointments because the objectives and vision described above still resonate today, with IMS advocated as the enabling architecture that will finally lead to service creation success in today's broadband/multi-media world.

2.1 Promises Met:
In fact, AIN capabilities enabled many services to be built. Once the infrastructure was in place, major service development intervals of 4 to 6 months were much faster than the then 12 to 18 month vendor intervals. As a service was being defined, delivered and deployed, it could be customized quickly, and prototype offerings could often be demonstrated in a matter of weeks.

There was considerable discussion and rather different views regarding the IT sophistication that was required to successfully build and deploy AIN services. Decision Graphs or vendor-provided SIBBs were presumed by many to be sufficient to create the vast majority, if not all, of the new services that the market would demand. There was a claim at one point that a major Service Provider would deploy hundreds of services in the next year using these capabilities. In contrast, there were Service Providers who saw the need to establish robust internal IT organizations that programmed high-level languages to manipulate AIN platform components.

As an example, Service Providers highlighted services they had developed internally on a regular basis at industry symposia. [5] AIN was able to address a wide variety of services. Furthermore, a service could be market-trialed without needing to make a major investment in additional network infrastructure. Because AIN was a service platform, multiple applications could be offered from the same SCP, helping to minimize costs for services that did not fundamentally require access to a bearer connection for their functioning.

With regard to standards, service creation had essentially no standardization; network element functionality was driven by BellCore requirements, but somewhat different subsets were supported by vendors; and operations interfaces were vendor and Service Provider specific. Despite these issues, the architecture was comparatively simple (versus NGN and IMS), and this helped enable Service Providers to quickly deploy the architecture and make use of it for service creation.

As is typically the case for an emerging technology, AIN Operations received little attention for many years. Service Providers wrestled with operations issues without a framework to approach the challenges. Ultimately, Service Management Systems (SMSs) were developed that addressed key challenges related to SCP and SN network management; service and subscriber data management; number plan change impacts; critical flow-through provisioning from legacy operations support systems; and fundamental fault management. SMSs functioned as combined element/network/service managers, with their functionality simplified by the limited number of components in the architecture. Functionality was developed incrementally as business success drove the need for its creation.

2.2 Disappointments:
While many features were built, for the most part they met with limited marketplace success. The Calling Name Delivery service was a striking exception.[1] This service provided funding shielding for some AIN programs. Regulatory requirements for Number Portability also leveraged the AIN infrastructure and hence helped drive additional Service Provider investment in AIN. However, it was a rare service that could attract even a 5% penetration within the consumer marketplace. Consumers were typically content with Call Waiting; Calling Name Delivery; Voice Mail; and in some cases, Unidentified/Private Number Screening.

The inherent usability limitations of basic telephony were clearly an issue. Consumers already had difficulty using their Transfer and Conferencing features; list management and feature administration were cumbersome at best; and access codes were hard to remember when the service was infrequently used. Unless a service was genuinely simple to use, its likelihood of success was quite small. This experience was further dependent on the limited I/O capabilities of typical wireline telephone sets, suggesting that high feature cell phones and GUI's for web or client-based feature management and control could materially change these results, particularly given pervasive customer experience with web-based Internet applications. The more "moving parts" in a service, the more crucial usability was to its success.

[1] Calling Name Delivery (and Local Number Portability) use service-specific triggers versus the general AIN triggers. Their basic feature mechanism is consistent with the AIN Call Model.

In many ways, the limited number of highly successful AIN services saved Service Providers from needing to comprehensively address feature interactions. The management of feature interactions within a central office switch, which is a very contained and predictable environment, requires significant development and testing attention and effort. In an AIN environment, where services can be developed independently and potentially require use of the same SSP trigger, the complexity of these challenges is exacerbated. The key problem is identifying the center of control for a given customer's service and ensuring it has access to the needed information to prioritize and resolve inter-feature conflicts. In an open environment, this problem takes on much greater complexity and challenge.

Given the belief in what services the technology could enable, there was a strong push for Open AIN, which provided the ability for third-party providers to develop and offer services to Service Provider customers in an independent manner. Considerable attention and energy was expended in this arena. This work led to initiatives such as JAIN, PINT, SPIRITS and OSA/Parlay; [7] however, no significant third-party applications emerged as successful in the marketplace. The promise of an Applications Marketplace did not materialize; some advocates ascribed this to the closed nature of the SS7 environment and expressed a belief that the emergence of IP would overcome this hurdle.

In this time frame, neither wireless nor IP endpoints garnered significant mindshare from Service Providers. Mobile phone usage was expanding rapidly, but the focus was still primarily on dial tone support with problems such as handoffs between cells and roaming agreements as the primary focus. Power users were given some attention, and some "fancy features" were deployed for this user base. However, penetration levels were low because the offerings suffered from user interface design challenges and tended to require bearer facilities, which were expensive to deploy. Internet access was almost exclusively limited to dialup facilities, so IP received little attention.

In part due to the considerations discussed above and in part due to the inherent complexity of building telecommunications services, only limited (versus the expected substantial) cost advantages were achieved. There was real cost to maintain an internal development capability, especially for laboratories and proper testing support. Furthermore, an operations infrastructure to manage the AIN network elements, services, and subscribers, functionality typically supported by a combined element/service/network management system and changes to legacy systems, had to be created and implemented.

Finally, even if a highly profitable service could be defined and quickly implemented, the service still needed to be managed through the typically burdensome process for any new feature deployment within a large Service Provider. Integrating the feature into the customer service representative repertoire; working the tariffing issues; and identifying and funding the IT/Billing/Operations Systems support that was required were examples of the "heavy lifting" that did not move at AIN speeds. Note that this also assumed that a consensus on service definition had been established within the Service Provider.

3 Back to the Future – Part II: 2000 - NGN – "IP to the Rescue":

Given the limited success of the AIN architecture and approach, a view began to develop that the then emerging Internet "wave" held the key to achieving some of the more elusive AIN objectives. There was a notion that web developers would become the third-party services programmers. There would be many innovators working in this new environment, and they would finally break through the barriers that the closed SS7 AIN environment had posed, with SIP and XML prominently mentioned as key elements in the toolkit of these innovators. In many ways, the objectives of the original AIN vision remained the same – however, IP would be the key that would open the door to meaningful progress and enable genuine success to occur.

In this environment, NGN architectural thrusts gave rise to further decomposition of the central office switch, using softswitches, gateways of various flavors, feature servers, and media resource servers. IP could provide a much more open mechanism by which service logic and bearer control could be decoupled from the telecommunications infrastructure that accessed it. Access-agnostic services provided from an IP-connected core had great potential for addressing the shortcomings that SS7-based AIN had brought. A next generation Communications Service Architecture (see [8] Figure 3) began to emerge, fueled by the potential of Voice over IP; the increased separation of transport, switching and service logic; and a belief that innovative IP-based services that would now be possible in a much more open programming environment. SIP and XML were seen as stepping stones on this path, although there were clear timing challenges related to early developments that had already progressed down other paths, for example using H.323 signaling.

At the heart of this approach was a fundamental paradigm change. The AIN/SS7 Class 5 central office switch, with its triggers and messaging, was being disaggregated. Literally, the internals of the Class 5 switch were being distributed over a wide area network that consisted of softswitches, gateways and servers. [9]

Trunk and Line access interfaces were migrated into Gateways. Intra-switch bearer transmission was migrated to an ATM/IP/MPLS core network. Signaling interfaces were migrated to signaling gateways. Call control was migrated to Softswitches or Call Agents. Feature logic was migrated to distributed application or feature servers. Third-party providers could manipulate the underlying network infrastructure while Service data could be migrated to LDAP directories. System administration began to center on the management of Policy servers. Customers would have the ability to manage their service profiles through web-based interfaces.

3.1 Promises Met:

Given the NGN focus on an IP core with disaggregated bearer and service control, the architecture naturally and efficiently extended to handle IP endpoints. The potential for media and service convergence became apparent and motivated voice/data/video converged services pursuit.

Voice over IP (VoIP) endpoints could directly connect to the core IP infrastructure without needing to interwork with gateways connected to the wireline/TDM infrastructure. While there was discussion of VoIP at the consumer level, the main opportunity for incremental revenue for established Service Providers lay in the enterprise arena, where data networking needs and its associated existing infrastructure could potentially accommodate the resulting voice traffic bandwidth.

Another equally important impact of this architectural thrust was its facilitation of new entrants (e.g., Vonage and Skype), in particular where end-user access to their telecommunications services was broadband (whether DSL, FTTx, or cable-based.). Broadband access was exploding, and the model where voice was simply another broadband service began to be pursued. Broadband access facilitated data services that in most cases were not closely coupled to telephone service; in this environment, VoIP enabled significant feature functionality that was fundamentally end-user controllable at the network's edge. This model expanded the set of Service Providers, although it did not change the landscape with regard to third-party services incorporation.

3.2 Disappointments:

The NGN model is both elegant and powerful. It is also extremely complex. The exposure of previously internal interfaces increased the standards challenges far beyond what AIN/SS7 had to cope with. In addition it introduced an integration challenge that had primarily been addressed within the internals of network element suppliers by driving the industry from a pre-integrated model to a "best of breed" approach. This significantly increased the need to reconcile release content and timing for multiple independent components, where the details must be mastered for there to be success. Standards fell short in their role of mitigating or eliminating the need for this reconciliation.

More fundamentally, there was no equivalent of the detailed AIN Call Model, as this thrust was primarily protocol-driven. At one point there were more than 40 softswitch suppliers seeking to enter the market. Given the lack of a commonly accepted model, the resulting products reflected different decisions on how and where what functionality should be packaged, affecting the interfaces that needed to be supported. There were economic tradeoffs between deploying multiple physical components supporting specific functionality versus combining functionality in a given component. Given that the softswitch needed to interface and control a variety of gateways, the potential combinations that a vendor faced in meeting multiple Service Providers' needs was overwhelming. The net effect of this was to increase the level of confusion in the marketplace.

These were serious challenges. More motivation to address them could have been provided by the emergence of one or more "killer" applications that leveraged the unique promise of IP endpoints. Unfortunately, this has not turned out to be the case, and as a result, the economics for migrating to such an approach have not been compelling for established Service Providers. Other than enterprise-focused IP-PBX offerings, significant revenue generating opportunities have not yet manifested themselves for established Service Providers. Consumer VoIP has been experimented with by incumbents, but to date significant commercial deployments have been only seriously pursued by new entrants. One can envision greater consumer deployment as the cable infrastructure becomes more capable of supporting VoIP over an engineered network.

4 Back to the Future – Part 3: 2005 – The Emergence of IMS:

The IP Multimedia Subsystem (IMS) architecture has received great attention within the NGN community. [10, 11] This architecture, which has arisen out of the Third Generation Partnership Project (3GPP), addresses wireless services but does so in a manner that can naturally extend to additionally support Wireline and IP access. [12] The architecture is still in a formulative stage, and the details and standards for this architecture are still being worked out. It is promising, however, that the architecture directly addresses a key shortcoming in NGN where no generally accepted organizing model was defined.

The architecture relies on a centralized customer profile that encompasses both static and dynamic data in the Home Subscriber Server (HSS.) The HSS also hosts downloadable filter criteria that provide the potential to gracefully manage basic service interactions across the complete spectrum of access methods in the Transport Plane, logically and physically separated from the Service and Control Plans in product implementations. This has been a key shortcoming of AIN and NGN, and is a meaningful step forward that also facilitates service operations management.

Augmenting the S-CSCF with the Service Capability Interaction Manager2 (SCIM) can provide differentiated handling for features that have complex conflicting behavior or need sophisticated coordinated treatment. The main significance of this architectural thrust is its ability to inter-work convergent services that span diverse access point types. In particular, a key motivation to adopt an IMS approach would be the need to incorporate wireless endpoints and their associated services. Wireless handsets support end-user functionality with far superior usability compared to their wireline counterparts. There is significant work in progress to enable a seamless transition between mobile and wireline environments. While wireless services have a significant independent play in the marketplace based on their capabilities for multi-media support and presence capabilities, they also will increasingly represent an "extension" of many subscribers' basic non-mobile service. The ability to manage such convergent services could provide a major motivation for investing in an IMS framework

The IMS architecture emphasizes the use of SIP as its nearly universal interface protocol. This is positive; the downside is that there have been a plethora of SIP-Extensions that have arisen that have undercut the utility of the approach. These extensions are clearly driven by needs that have not been met in the SIP standards to date, underscoring the difficulty of identifying a minimal set of standards in advance of significant experience with their use in practice.

The fact that IMS is being carefully considered as a unified services architecture (with S-CSCF/SCIM enabling access to SIP, IN and OSA/Parlay applications) offers the hope and expectation that the NGN architecture degrees of freedom will be reduced and a definitive services model will emerge. At this time, however, the architectural components in IMS are more numerous than in NGN. This is a serious concern because complexity has non-linear impacts on cost and schedule.

Furthermore the growing interest in IMS is driving vendors to have "IMS compliant" products that can result in pre-standard implementations that mirror the industry's experience with NGN. In the absence of a mature model with reduced complexity, suppliers will independently produce products that will compromise the industry's ability to realize a uniform model that facilitates "plug and play" components. Integration costs in such an environment will dominate other considerations, and lead suppliers will solve these challenges either directly within their product lines or alternatively with some limited partnering.

The key question, of course, centers on the revenue drivers that will motivate investment by Service Providers in IMS. This is more difficult ground. Wireless opportunities are a serious growth area within telecommunications. However, much of the industry interest in IMS is driven by the potential it brings for supporting converged services that bridge the wireline and wireless networks. The notion that an intelligent services architecture will lead to a flowering of new services is not a new one. However, the complexity inherent in converged services does not bode well for broad acceptance of such offerings.

It will be interesting to see where such value will emerge, and how substantial it will be. Experience to date has been that complex "fancy" services have a limited market. History tells us it will be crucial to "hide" such service complexity by supporting "simple" user interfaces and thoughtfully defined "default" behavior which can be simply customized as user sophistication increases. In truth, we have very few examples where highly complex telecommunications services have had broad consumer adoption, yet this is what will be essential to drive major investments for convergent services.

The above considerations are further affected by the reality that in today's world, there are typically multiple Service Providers involved in an individual customer's service. The ability to centralize and manage data in the HSS will be crucial to success for services that span multiple independent networks. However, inter-provider agreements and mechanisms will need to be implemented to support the requisite data flows for such federated services. In a world where convergent services drive IMS investment, it will be crucial to resolve technical, and as importantly, business issues between these providers. "Ownership" of the customer will be an issue that arises from this, and it will be a very difficult one to resolve. In the near term, Service Providers are more likely to compete than cooperate.

Given all this, the "applications marketplace" originally envisioned by Open AIN and later presumed to emerge from small scale Java or "internet-like" service

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[2] SCIM is comparable to the Service Broker in the MultiService Forum R2 architecture.

developers doesn't appear to be any closer to emerging. The most promising driver would seem to be "click-to-talk" applications provided over web services, where basic communication capability would be what was fundamentally required.

The drive towards a common HSS repository will help simplify service management and provisioning. Typically, standard widespread OSS solutions emerge after the technology it must manage has matured. We are still in the formulative stages of IMS. While some operations efforts can be migrated to end users given GUI capabilities, the complexity of CPE administration and network security protection raise challenges as significant service deployment is pursued that capitalizes on enhanced end user functionality. Given this, we should not expect standard operations approaches to emerge until the requisite maturation is much further along.

5 Summary:

The incorporation of IP into the AIN-enabled PSTN significantly increased the complexity of the service architecture for incumbent operators while facilitating the entry of emerging Service Providers through broadband access. There have been few market-successful innovative service offerings to date. IMS has the potential to reduce this complexity while extending the architecture to support convergent (wireline, wireless, IP and multi-media) services. The success of this architecture will depend on the demand for such services. Success in this regard is far from guaranteed. Identification of compelling revenue drivers and resolution of difficult business arrangements require immediate attention. Furthermore, the consequences of the technical complexity that still remains should not be underestimated. Unless these challenges are met head on, fragmentation in supplier products will co-opt much of the promise for plug and play standard products with third-party incorporation.

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