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Choosing a Future Generation Session Border Controller Platform

Industry Trends in SBC Design and How to Pick the Right One for You

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Executive Summary

In an increasingly competitive world, there is much at stake for service providers as they look towards the future. The networks that will power future generation IP services must be architected to deliver high-octane user experience with iron-clad security. They must appeal to new as well as existing subscribers while minimizing cost. And they must have the flexibility to expand and adapt with shifting market dynamics. Session border controllers (SBCs) will play a major role in these networks.

The vast majority of SBC deployments to date have leveraged systems designed specifically to perform SBC functions. These SBC platforms combine purpose-built processing with tight integration of signaling and media controls in a single network element. The question going forward is whether that approach will continue to satisfy the requirements of future-generation services. In recent months new platform designs and deployment models that compete against integrated purpose-built SBCs have emerged with the claim that these approaches are more scalable, more flexible, or both. Service providers only stand to benefit from these increased options available to them. In the end, however, each service provider will need to evaluate their network, service requirements, and choose from among the range of platform choices and deployment models along with comprehensive SBC features that can solve all of the complex challenges that lie ahead for them.

While the majority of future generation services will continue to be best served by integrated, purpose-built SBCs, service providers cannot ignore the new breed of SBCs as virtual network functions (VNF) now entering the marketplace. To be sure, while the integrated purpose-built platforms will continue to evolve and deliver the boost in performance, capacity and throughput necessary to address increasingly diverse requirements at both the access edge and interconnect borders, service providers should look to SBC vendors who can provide a comprehensive range of purpose-built platforms as well as fully functional virtualized SBCs, deployment models for them to co-exist, and the orchestration tools necessary for the realizing the full benefits of such deployments.

Introduction

Poised for explosive growth over the next several years, end-to-end IP services are no longer “the next big thing” in communications. With the first voice over long term evolution (VoLTE) services launching in 2012, a report from leading communications industry analyst Infonetics Research estimates that VoLTE services will reach over 100 million subscribers in 2015 with three-fold growth by the end of 2018.

Another published report by market intelligence firm Signals and Systems Telecom indicates that voice over mobile broadband (VoMBB), consisting of 4G VoLTE and voice over high speed packet access (HSPA), could actually reach 450 million subscribers by 2016.

VoLTE and other emerging IP communications services, including video calling, cloud-based services (video, unified communications) and “over-the-top” (OTT) services that will utilize Web-based real-time communications (WebRTC) or other techniques, are among the next wave of “game-changers” that service providers will count on to attract and retain a new generation of subscribers in the face of mounting competition from upstart providers like Skype, Facebook, and Google.

These new services will generate significant volumes of increasingly complex IP traffic on service provider access networks, between mobile operator networks and between fixed line and 3G/4G mobile networks. The networks built for these future generation services will have to meet several important criteria:

- Capacity to handle the large volume and complexity of the signaling and media traffic that will be generated by these services
- Ability to encrypt all signaling and media at wire rate to comply with VoLTE requirements and deliver privacy, confidentiality, and integrity for new OTT offerings
- Ability to deliver high-capacity transcoding for new HD and VoLTE-capable mobile endpoints that will interoperate with existing services based on traditional endpoints; and
- End-to-end manageability to assure service levels and reduce OPEX

A key network element in next-generation services will continue to be the SBC. In fact, service providers now consider SBCs strategic in the success of their networks and, by extension, their services:

- SBCs control all signaling and media in real-time IP communications services and are responsible for ensuring security, interoperability, quality, reliability and regulatory compliance, all of which are critical to the success of those services
- SBCs are located at IP network borders, serving as the network demarcation point between individual subscribers and service providers, between enterprises and service providers and between fixed and mobile service provider networks.

Considering the trends described above, the functions performed by SBCs are not only critically important in today’s networks, they will become even more important over time as new services are introduced.

While SBC software provides the intelligence used to control IP session traffic, it’s the SBC hardware platform that will provide the muscle necessary to scale those controls to the extent needed to support new IP services and the massive number of subscribers that will use them.

The growing importance of SBCs has not gone unnoticed by equipment makers looking to gain a share of the growing market. The result has been a slew of SBC products from these vendors, each claiming superior design and implementation.

With an increasing number of choices moving forward, service providers evaluating next-generation SBCs must evaluate the various designs and architectures being put forth now, in order to make the correct choice for the future.

Infrastructure Requirements for Next-Generation Services

Over the next several years, service providers will be looking to develop new ways to deliver content-rich, multimodal communications services to a new generation of would-be subscribers. These new services will undoubtedly be based on an all-IP network and will have increased requirements for performance, capacity, throughput, security and other functionality.

The following is a short overview of emerging next generation interactive IP communications services and their concomitant infrastructure requirements.

VoLTE

When VoLTE is fully implemented, it will drive massive volumes of signaling and media traffic at the IMS access edge and mobile interconnect borders, as well as the interconnect borders between mobile and fixed line networks. Since the baseline VoLTE profile mandates the use of IMS authentication and key agreement (AKA), support for high-capacity, wire-rate encryption will be needed at border locations.

High-capacity transcoding will be needed at interconnect borders to support VoLTE due to its use of the AMR Wideband codec. Media quality will also be of primary concern to operators, particularly when VoLTE services utilize existing LTE networks that are also used for data services.

Video Calling and Conferencing

Over time, mobile and fixed line subscribers will increasingly leverage video calling services, either as: 1) a standalone application; 2) within the context of video-enabled services such as hosted unified communications (UC); or 3) from browsers leveraging HTML 5.0 and WebRTC.

Video will drive significantly increased bandwidth consumption due to the bandwidth requirements of HD audio and video codecs, as well as longer hold times. Signaling volume and complexity for video-enabled communications will also increase significantly. Finally, transcoding may play a significantly more important role in the future as new codec variants emerge and as end-users begin to demand interoperability between proprietary and standard codecs.

SIP Trunking and Hosted Services

While SIP trunking may be considered a current (rather than future generation) service, the SIP trunking market is still growing, as enterprises continue to embrace applications like VoIP, UC and IP videoconferencing. The trend towards migrating applications such as these to hosted or cloud-based, models has begun. Much of the future growth in SIP trunking will come from these more sophisticated services. They will drive increased signaling and media traffic volumes into the service provider core, as well as to interconnect borders when the sessions don't terminate at a PSTN gateway.

The diverse set of applications running over SIP trunks will drive an increased need for media controls, including quality of service (QoS) and bandwidth management functions. These services will also drive the need for high-volume transcoding on access networks to achieve greater trunk utilization.

HD Voice

According to a 2014 report by the Global Mobile Suppliers Association (GSA), HD Voice services are commercially available on 109 GSM, 3G, and LTE mobile networks worldwide, in a total of 73 markets, and the number of operators supporting the technology has risen by 40 percent in less than a year. Regardless of whether HD voice is offered as a standalone service or a technology embedded in other services such as VoLTE or video calling, HD voice will drive both increased bandwidth consumption and transcoded session capacity at interconnect borders.

Rich Communications (RCS/RCS-e)

IMS-enabled RCS services, which also encompasses RCS-e (Rich Communications Services-enhanced), integrates a series of capabilities, such as telephony, instant messaging, video/photo/file sharing, and presence, which will generate significant SIP signaling traffic. Most of the media burden will be limited to the telephony component; although, access to RCS/RCS-e over public Wi-Fi requires TLS/SRTP or IPsec encryption as well. Therefore, most of the impact from RCS/RCS-e will be in managing signaling volume and complexity.

WebRTC and other OTT Services

Web-based Real-time Communications (WebRTC) is not actually a service. Rather, it is an enabler for a future generation of Internet-based, over-the- top (OTT) services that service providers could use to compete against traditional OTT providers such as Skype or Google. As of this writing, the definitions and standards for WebRTC, as well as other OTT service-enabling technologies, are still evolving. It's still not clear when mass adoption will take place or how services will be monetized over time.

On a technical level, since WebRTC standards define only the media, the choice of signaling protocol will be left to application developers, which could extend requirements for signaling interworking. All media will be SRTP encrypted and the media composition will include audio, video, and data, which will drive up bandwidth requirements. Other OTT technologies project to be encryption and/or tunneling-heavy as well as multimodal, meaning bandwidth and demand for media control functionality will also be high for those services.

The table below summarizes each of these emerging services and technologies and briefly lists the primary requirements for future generation SBCs.

TABLE 1: SBC REQUIREMENTS FOR SERVICES

Service/Technology	Primary SBC Requirements
VoLTE	» *High system throughput* » *Multiple 10 Gbps I/O* » *High capacity encryption* » *High capacity transcoding* » *QoS enforcement*
Video calling and conferencing	» *High throughput, multiple 10 Gbps I/O* » *High signaling performance and capacity* » *Video and audio transcoding*
SIP trunking and hosted services	» *High capacity signaling and media* » *QoS enforcement* » *Transcoding for trunk efficiency*
HD voice services	» *High system throughput* » *Multiple 10 bps I/O* » *High capacity transcoding*
RCS/RCS-e	» *High capacity signaling* » *Limited media controls and encryption*
WebRTC and OTT services	» *High capacity transcoding*

SBCs on Purpose-Built Platforms

Some SBC vendors point out that purpose-built systems are a) more expensive; b) based on antiquated hardware; c) inadequate to meet the needs of future services or applications; or d) not "carrier grade." While there may be a grain of truth to some of these statements, they don't tell the entire story.

Simply put, SBC hardware platforms engineered specifically to perform critical SBC functions are more likely to succeed in high-volume services than systems designed for other purposes or for no particular purpose. Part of the reason lies in how purpose-built SBCs are designed. Purpose-built systems leverage an architecture that dedicates processor resources to specific compute intensive functions in a manner that delivers media latency far below the minimum levels required for high quality audio and video. Functions such as encryption, transcoding, DoS prevention and QoS monitoring all benefit from dedicated hardware tightly integrated with the rest of the system.

Purpose-built SBCs separate functionality in a way that prevents unauthorized traffic or traffic exceeding configured limits from reaching processor resources that must be reserved for authorized or policy-compliant traffic. They assign trust levels in a dynamic fashion, based on constant monitoring of session state, and they do so for the thousands of sessions that terminate simultaneously in the system.

SBCs, by definition, function as back-to-back agents, terminating and then re-initiating both the signaling and media flows that comprise real-time communications sessions. In this capacity, SBCs must perform a number of separate but intimately related tasks. They often must decrypt then re-encrypt protocol messages. In between the decryption and re-encryption functions, they must perform deep packet inspection in order to ensure that each packet entering the service network is not only authorized and compliant, but also not illegally appended with unauthorized content. SBCs must at times replicate media or signaling packets for recording.

They must gather statistical information from RTCP packets in order to generate MOS scores or perform routing calculations based on media quality or offered codec. All of these functions, and many others too numerous and complex to cover within the context of this paper require a purpose-built design so that all are executed correctly and at full wire rate, even with the system under massive load.

SBCs must be fully session state-aware. Tight integration between signaling and media processing is essential for maintaining full session state. This is performed far more efficiently and effectively in an integrated, purpose-built system. State maintenance means constant monitoring of endpoint behavior so that access controls can be adjusted dynamically as needed.

State maintenance involves constant check pointing of signaling, media and configuration state between primary and secondary elements in high availability (HA) configurations. Only integrated, purpose-built SBCs have been proven effective at performing these functions in this way.

Because of their intricate designs, purpose-built SBCs are typically more power and space-efficient than other types of platforms. In fact, top selling models supporting tens of thousands of simultaneous real-time communications sessions in some of the world's most complex service environments are often implemented in a 1RU form factor (more commonly 2RU in HA configurations) that looks more like a desktop router than a NEBS-compliant carrier grade system.

Finally, only standalone, integrated SBCs are truly field-proven. For over a decade as of this writing, SBC vendors have touted alternative approaches to the standalone purpose-built SBC, yet in evaluation after evaluation, trial after trial, and live deployment after live deployment over the years, standalone purpose built systems have consistently demonstrated a unique ability to handle all of the complex challenges introduced by high-volume applications that were, after all, never intended to be run over IP transport.

Advent of SBC as a Virtual Network Function

Virtualization of network functions came into a sharp focus with a 2012 publication of a white paper from a group of network operators and formation of an ETSI Industry Specifications Group (ISG). In the white paper, the operators argue for software based approach to network functions that had traditionally been performed in hardware. More operators have since joined in the effort and have provided updates to the initial paper. These updates have helped to bring in more clarity to the service provider view. ETSI ISG on NFV has published a number of specifications detailing infrastructural, architectural, quality, performance, resiliency, management and orchestration, etc., aspects of NFV.

The Promise and Perils of SBC Virtualization

In addition to the well understood advantages of virtualization which include: increased network agility, elasticity, and freedom from proprietary hardware, virtualizing the SBC promises other benefits as well such as faster introduction of new services and faster failure leading to faster innovation cycles and introduction of niche services that previously might have been overlooked because of limited popularity. In addition, new deployment models allow dedication of one or more instances of SBCs to a customer circumventing the problems of multi-tenancy. Scalability on demand also helps in SLA maintenance and improved user-experience.

TABLE 2: TRADITIONAL VS VIRTUALIZED SBCs

Comparison	Traditional SBC	Virtualized SBC
Underlying hardware	Purpose-built with support for most common SBC functions	Commercial-off-the-shelf (COTS)
Reliability and availability	Strong reliability and high availability	Strong reliability and high availability
Monitoring and management	Straightforward	Complex, when tied to orchestration tools
Scalability	Capacity addition in non-linear large blocks	Granular, grow as you need linear capacity
Capacity utilization	Potential idle session capacity	Lock-step with requirements, capacity when needed
Encryption and transcoding	Utilizes specialized hardware such as DSPs	Done in software; may potentially require large amounts of CPU power

The biggest challenge in virtualizing the SBC has been in the CPU intensive operations that it performs. SBC appliances have been expressly designed to execute these functions at near wire-speed. Because these hardware optimizations are not available in standard off-the-shelf servers, these operations cannot be done with the same speed and efficiency. These operations lie at the very core of SBC existence – DoS/DDoS protection, encryption, media processing, etc., and need to be performed well in order for any service that uses the SBC to succeed.

Figure 1 illustrates the conundrum. Purpose-built platforms provide the SBC software direct access to the data I/O pipe which eliminates delays. As the packet processing logic is moved to COTS and then to a VM configuration, the abstraction adds several software layers between the data consumer process and the physical hardware. These added layers are generally not an issue for signaling, but because of added buffering and potential copying of media packets between layers adds delay. Moreover, if the packets need to be processed further – such as transcoded or un-encrypted, the software has no access to hardware acceleration and must perform this using the virtual CPU at its disposal. This process consumes even more CPU cycles, reduces capacity, and adds even more delays and jitter into the media.

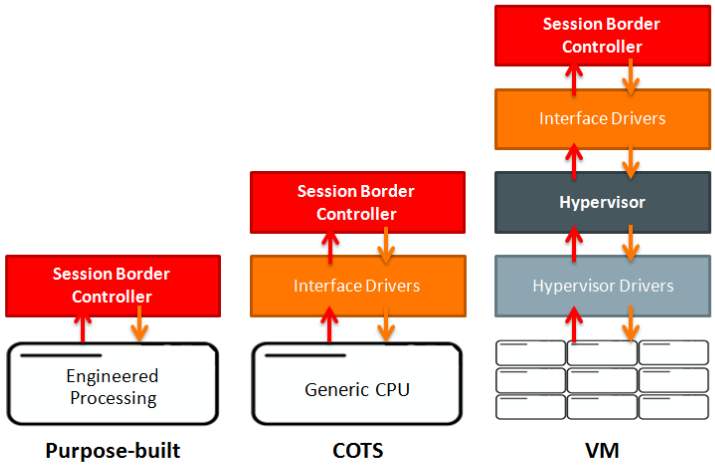

Figure 1: Software Layers in SBC Platform Choices

Another issue that CSPs must deal with is how to evolve their installed network from its physical underpinnings. Usually, rip and replace is not a viable option. Therefore, CSPs have to ensure that any virtualized network functions that they deploy must co-exist with their physical counterparts. Moreover, for complete service flexibility, all monitoring, management and orchestration solutions they deploy must be able to recognize and control both the virtual and physical resources present in the network.

CSPs must also consider the broader implications of network function virtualization. They must ensure that what they are getting is not simply the software version of what used to run in purpose-built hardware, but is supported by capable management and network orchestration (MANO) tools to help them realize the full benefits of virtualization. For example, these tools should enable automatic instantiation, configuration, and insertion of virtual function instances in the network dynamically without any downtime or manual intervention in response to traffic needs.

SBC Virtualization Done Right

CSPs should carefully consider all implications before selecting virtualized SBC that is right for them. The following paragraphs discuss the pertinent issues.

Virtualizing a network function, especially as complex as the SBC, is in most cases not simply a port of the software to run as a virtual machine. The software must be purposefully optimized to run in such an environment. For an SBC, this means that it must overcome the security and media challenges as outlined above. The following table shows the technology that a virtualized SBC has at its disposal.

Table 3: SBC-VNF Challenges and Innovations

Challenge	Objective	Virtualized SBC Innovation
Media capacity	Maintain low latency and boost capacity	Uses Intel's advanced technologies such as: Data Plane Development Kit (DPDK), Single Root I/O Virtualization (SR-IOV), and Poll Mode Driver (PMD)
Encryption	Enable higher volume	Exploits instruction set and chipset based functions
Transcoding	Enable the broad range as present in the physical SBCs	Uses Intel's Integrated Performance Primitives (IPP), software based look-aside functions, and other 3rd party plug-ins Allows, where required, a hybrid model where a common pool of hardware DSP resources may be utilized as required

DoS/DDoS protection	Line-rate protection against malicious attacks	Carries over physical SBCs strategy using look-aside functions and in-line with DPDK and PMD Isolates CPU cores for particular functions to minimize interruptions
Other media functions	This includes SSRC switching, MSRP, B2BUA, TCP switching, DPT mapping, TLS tunneling, etc.	Mix of software based approaches and chipset based capabilities

CSPs usually standardize on a set of hardware platforms and hypervisors for their datacenters. Any virtualized network functions they want to deploy should ideally be able to run on the selected platform and hypervisor combination. Therefore, vendor support of the virtualized SBC on a variety of popular hardware and hypervisors is important.

Virtualized and physical SBCs must coexist. In fact, one of the ways that CSPs introduce virtualization in their networks is to complement their physical counterparts and add capacity on demand. For SBCs, one way in which this can be accomplished is to cluster physical and virtualized SBCs together and use a load-balancing mechanism to distribute the traffic among all the elements of the cluster. In this way, network capacity may be increased or decreased on demand quickly and efficiently. CSPs looking for making their network elastic and responsive should consider this vital capability.

VNFs by themselves provide only an incomplete virtualization solution. Orchestration that manages virtual machine life-cycle can add more automation to the network. The ETSI NFV model specifies multiple levels of orchestration managing everything from physical infrastructure, VNFs, and the complete service.

TABLE 4: LEVELS OF ORCHESTRATION

Orchestration	Purpose
Application	Manage individual VNFs
Network	Multiple sets of distinct VNFs and the interconnectedness of those VNFs
Service	One or more networks, consisting of multiple sets of distinct VNFs necessary to deliver the intended service

CSPs selecting their virtualized SBC vendor should look deeper than their SBC offering into their orchestration products that they will no doubt use with the SBC.

Virtualization of network functions is in its early phase. Although some early adopter CSPs have embraced it wholeheartedly and announced their commitment, it is likely that VNF adoption by the majority will happen over several years. Therefore, CSPs must select suitable vendors with proven staying power and innovation commitment to stay on the leading edge of this transformation.

The SBC Platform Looking Forward

SBCs are, for lack of a more sophisticated description, extremely difficult to build. They are unique elements that are called upon to perform extremely diverse functions in extremely diverse environments that are anything but cookie-cutter. SBCs must tightly layer function/feature-rich software over a processor and system architecture that will enable all necessary functions to be performed at wire rate, even when the system is under attack or handling large session volumes.

Essentially, SBCs, which are and will be called upon by service providers to securely enable high-quality revenue-generating communications services for years to come, should be developed with a thoughtful, comprehensive, systems-level approach.

Taking into account the characteristics and requirements of future generation services, as well as the available hardware and software designs and approaches to deploying session border control, the SBC platform of tomorrow will, as just stated, share key attributes with the SBC platforms that have been successfully deployed by hundreds of service providers throughout the world.

But the SBC platform of tomorrow will be much more capable of taking on the challenges that future services are likely to introduce. Most importantly, it will be designed and built not only to deliver the levels of performance, capacity, and throughput necessary to power these future services over many years, but also the sometimes underappreciated aspects of deployment agility, capacity on demand, and the need to control capital and operational expenditure.

- Purpose-built platforms with distributed multiprocessing, 64-bit SMP capable operating system, and hardware acceleration to scale critical next-generation functions, such as encryption and transcoding, will remain work-horses of the service provider networks
- SBCs of tomorrow will feature flexibility and modularity to adapt to an ever-changing services landscape. This will include the ability to scale performance and capacity in a linear fashion and to accommodate new hardware to address the requirements of specific services and applications
- It will feature the ability to operate different software images on the same hardware according to the intelligence and set of functions required for the service or services
- It will be based on a familiar operations model and will operate the same software as previous generation SBCs to help service providers minimize OPEX and transition smoothly to the future
- Supporting set of products and tools to monitor, manage, and orchestrate SBC instances – no matter whether physical or virtual will form a vital part of SBC selection
- In keeping up with the digital economy, rapidity of service introduction, being able to scale swiftly, and – equally importantly – to wind up an underperforming service summarily, will be key in SBC selection

Vendor Selection May Be as Important as Technology Choice

While it is critical to select the correct platform architecture and SBC deployment model, it is equally important to choose the SBC vendor most likely to help ensure the overall success of the SBC deployment from the planning and purchasing phases all the way through to replacement and upgrade. These are the key attributes to look for in a SBC vendor as well as questions to take into account:

Focus: How dedicated is the vendor to session border controllers as a product? What's the level of R&D investment that the vendor has committed and is continuing to commit to the SBC products in its portfolio?

Portfolio: Is the vendor a one-trick pony? Do they offer just border control or the full portfolio of complementing products for a full service provider solution? Is their portfolio flexible enough to be used for VoIP, OTT, hosted services, converged IMS, Unified Communications, and is it designed to support services such as VoLTE, VoWiFi, RCS, etc., natively?

Support: Is the professional services organization staffed to the extent that it can assign resources as needed to issues as they arise? Can they assist with planning? Are they equipped to perform interoperability or solutions-level testing? Do they publish best common practices (BCP) documents? Do they offer comprehensive product training? Do they maintain communities and/or maintain support portals?

Experience and Expertise: How many years has the vendor been focused on session border control? How many live deployments can the vendor claim? How knowledgeable and experienced are the account teams? How active is the vendor in development or contribution to standards? Does the vendor engineer its own hardware and software or do they simply integrate a collection of off-the-shelf hardware and third-party software stacks?

Financial Health: Has the vendor grown over the years in terms of revenue and profitability? Is it the market leader in any of the products it sells? Does it have cash in the bank that can sustain it through rough periods? How many employees does it have and how many does it anticipate adding? Does its acquisition strategy make sense in terms of technologies or products acquired through other companies?

Vision: Is the vendor able to communicate a vision for the next 5-10 years? Is it constantly seeking new ways to solve problems? Does it continue to innovate and introduce new products? Does it engage in dialogs with other industry leaders about customer issues and technology directions? Does it innovate not only in technology but in the way it conducts business? Has the vendor expanded beyond being a one-product company?

Management Team: How long has the management team been in place? What are their backgrounds? Do they engage directly with customers? Are they responsive in the event of technical issue escalations? How well are they able to articulate the company's vision and plans?

Partnerships: Can the vendor deliver solution components beyond the SBC in an ecosystem? Is the vendor active in interoperability activities? Does it publish partner briefs, solutions briefs or "cookbooks" to help customers better understand how to integrate the different products? Does the vendor participate in industry associations and engage in business development activities meant to enrich the "whole" product offer?

Conclusion

The next several years will be critical for traditional service providers. The world of communications seems to be at a crossroads. IP-based services and infrastructure will clearly dominate going forward, but in addition to competing with one another, service providers are now competing against a wide variety of upstarts who are able to leverage the power and ubiquity of the Internet to deliver content-rich multimodal communications to a new generation of would-be subscribers.

Traditional service providers will have to come up with ways to productize, optimize and monetize new services that will win over future generations. It won't be easy, but with the advent of new services, such as the ones described in this paper, there is light at the end of the tunnel. SBCs hold one of the keys to continued success. In order to attract and retain new subscribers for new services as well as established ones, service providers will have to deliver better quality of experience, better reliability and better security than anything available via the Internet. They will have to comply with government regulations designed to protect the interests of consumers. And they will certainly have to be cost effective in order to be appealing. The SBC and all of the functionality it delivers adds value in all of these areas, making the SBC decision going forward as strategic as any other faced by the service provider.

Service providers now have a number of SBC vendors and a number of SBC platform choices from which to choose. At their essence, SBCs are based on software, not hardware. So the choice begins with the product that is most flexible, has the best and most comprehensive feature set, and is best able to deliver the intelligence necessary to solve the most challenging communications issues. Given that, the decision will come down to which platform, deployment model and vendor can best deliver the right solution or range of solutions. Vendors who offer only a single SBC platform will ultimately sell themselves, and their customers, short. Over time, a wide variety of services and service deployment models are likely to emerge as service providers continue to compete.

Successful SBC vendors will therefore be able to offer a range of platforms and deployment models to best accommodate the requirements of an increasingly diverse marketplace.

Oracle Communications SBC

Oracle Communications offers the most diverse range of SBC platforms – both purpose-built and virtualized. For more information on SBCs and other network infrastructure products, please go to http://www.oracle.com/communications or contact us at oraclecommuncations_ww@oracle.com.

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