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White Paper

Session Border Controllers: Addressing Tomorrow's Requirements

Prepared by

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Introduction

Almost a decade ago, as VoIP deployments commenced, the concept of a session border controller (SBC) emerged. The initial focus for SBCs was to provide secure access to VoIP-based services and to support "peering" functionality to enable VoIP networks to interwork directly without having to convert signaling and media streams back to TDM.

While security remains a key SBC function, over the past five years, as VoIP penetration has continued to increase in both fixed and mobile networks, the role of the SBC has continued to expand to support additional services and capabilities, including call admission control, interoperability between SIP variants and transcoding.

And given IP adoption is forecasted to rise significantly in the next few years as IP-enabled radio access networks (RANs) are deployed with IP core networks such as IP Multimedia Subsystem (IMS), we believe the relative importance of the SBC will continue to increase.

Accordingly, in this white paper we examine how IP-based service innovation will impact and shape the future of the SBC.

Architecture & Implementation Considerations

In this section of the white paper, we provide additional background on SBC architectural and deployment considerations.

The Session Border Controller: An Architectural Perspective

From an architectural standpoint, SBCs are unique from several perspectives. Firstly, SBCs can be considered both a core and edge device. This is in part because SBCs have been defined by standards as supporting core CSCF functionally as well as the fact that depending on the role required, they can also be deployed at the edge to protect the network and act as first point of contact.

In addition, given the distributed nature of next-generation networks (NGNs), components tend to support the transport of either the signaling plane or media "bearer" plane – but not both. Examples of signaling-centric devices include the IMS CSCF, Application Servers, and Signaling Gateways, while media-centric devices include Media Gateways and Deep Packet Inspection (DPI) appliances.

In contrast, as shown in **Figure 1**, in an IMS context the SBC supports a number of vital signaling and media functions. While this difference may not outwardly appear to be significant, we believe it does have the potential to fundamentally shape the evolutionary path going forward as the level of complexity on both planes increase. Moreover, supporting signaling and media also makes it more feasible to support an alternative number of design approaches. This topic is discussed in greater detail below.

Figure 1: SBC Mapping to IMS Functions

IMS FUNCTION	SIGNALING PLANE	MEDIA PLANE	DESCRIPTION
P-CSCF	✓		Proxy CSCF allows devices to register with the network
ALG	✓		Application Level Gateway functions as a SIP B2BUA between networks
AG		✓	Access Gateway is utilized to relay media traffic originated by terminals with an IMS deployment
IBCF	✓		Interconnection Border Control Function is utilized for forwarding SIP messages to other networks
IWF	✓		Interworking Function is typically utilized to support interworking of legacy applications (i.e., IN-based) with IMS systems
TrGW		✓	Transition Gateway supports various network and IPV4/IPV6 translation functions

Source: Heavy Reading

SBC Functionality Summary

If there is one key takeaway from the previous section, it's the realization that given unique characteristics, SBCs are architecturally well suited to perform a number of critical and diverse roles in NGNs, as shown in **Figure 2**.

Figure 2: SBC Functions in NGNs

SBC FUNCTIONALITY	DESCRIPTION
Media Transcoding	Transcoding supports the conversion of media from one format to another. In a telecom context SBCs can be utilized to support transcoding between fixed, mobile and IP codec formats.
Protocol Interworking	Protocol interworking supports the bridge or control functions to enable two network protocols to interwork. Examples include IPV4 and IPV6 interworking
NAT	The Network Address Translation supports modification of IP addresses in the headers of IP packets. The key benefit of this approach is that it allows a single IP address to support a group of IP devices
Topology Hiding	Topology hiding is utilized as an approach to enhance network security. Since critical IP address data is forwarded to other networks, the concern is that third parties can determine complete IP address information and hack the network. In topology hiding the SBC is used in a B2BUA configuration to reinitiate the session so that to terminating networks it appears the session originated only from the SBC.
Admission Control	Admission control refers to active monitoring of inbound and outbound traffic to ensure network design thresholds are not exceeded. In cases where there is insufficient signaling or media capacity, the SBC may take steps to throttle traffic and block new sessions from entering the network.

Source: Heavy Reading

Challenges & Design Considerations

In this section of the white paper, we consider the ongoing challenges that SBCs face and their impact on future SBC designs.

Quantifying IP Network Challenges

Although the deployment of IP networks represents a quantum leap for telecom operators from the perspective of service delivery potential, IP technology also introduces a new set of challenges for these telcos to consider. At a high level these can be considered as either scalability-related or security-related.

Scalability

From a scalability perspective, there are a number of challenges. For all operators there are concerns related to volatility and growth of video usage carried over the media path. As well, especially for mobile operators, the additional signaling impacts of devices such as smartphones and applications such as messaging and presence must be considered.

Security

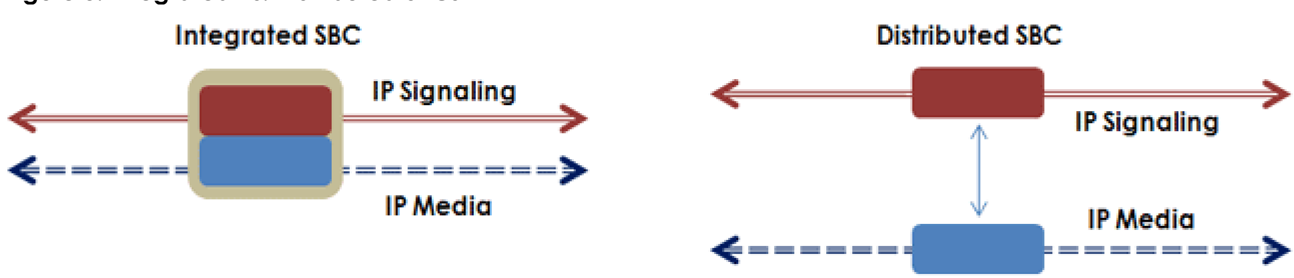
Given they are designed as open systems, IP networks are inherently susceptible to denial-of-service (DoS) attacks, with the overall threat level increasing as the level of IP penetration does. Moreover, since next-generation architectures such as IMS are highly distributed, there are a greater number of interface and functional nodes that must be monitored and secured.

In addition, the adoption of more intelligent user devices such as smartphones increases the potential for injecting malware into the network via application downloads.

SBC Design Considerations

As documented in standards, SBCs support two main implementation approaches: distributed (sometimes referred to as decomposed) and integrated designs. As shown in **Figure 3**, the differences are straightforward. In the integrated design, a single device supports both the signaling and media planes, while the distributed SBC physically separates these functions at a hardware and software level.

Figure 3: Integrated vs. Distributed SBCs



Source: Heavy Reading

While both approaches described are fully standards-compliant and valid, the vast majority of deployments to date have been based on the integrated architecture. Accordingly, there are some views that the distributed model will never be deployed given carrier preferences and pricing models. In this regard, while economic and market forces will ultimately drive adoption preferences, we assess the distributed model as possessing a number of desirable traits including design flexibility, which makes it well suited to meeting future demands and challenges.

For example, the signaling plane is increasingly an area of concern for operators. While forecasting both media and signaling plane traffic is very difficult given the volatile nature of multimedia services, the adverse signaling impact of smartphones has been well documented over the past 18 months. And one of the lessons learned from this exercise is that while mobile sessions are typically shorter in duration, their interaction with applications translates into a greater number of concurrent sessions which strain the SBC's signaling plane.

Having a solution that provides physical separation in two products should make it easier for vendors to exponentially upwardly scale signaling plane performance metrics as required. Similarly, this architecture enables operators to geographically place media components at the access edge to improve overall network performance and user experience, and to minimize backhaul costs.

Moreover, SBCs were not defined in the standards as a single product, but grew and gained momentum based on specific network operator requirements. Based on this reality, new functions could potentially be deployed in SBCs, so having a distributed architecture allows this evolution in a more elegant manner.

Finally, utilizing a distributed approach is also consistent with next-generation IMS core network design and cloud based architectures. However, in this regard, distributed architectures should not be considered as an unproven approach, since even legacy networks adopted this methodology 20 years ago when they deployed SS7 Signal Transfer Points to separate signaling from the bearer path.

SBC Use Case Scenarios

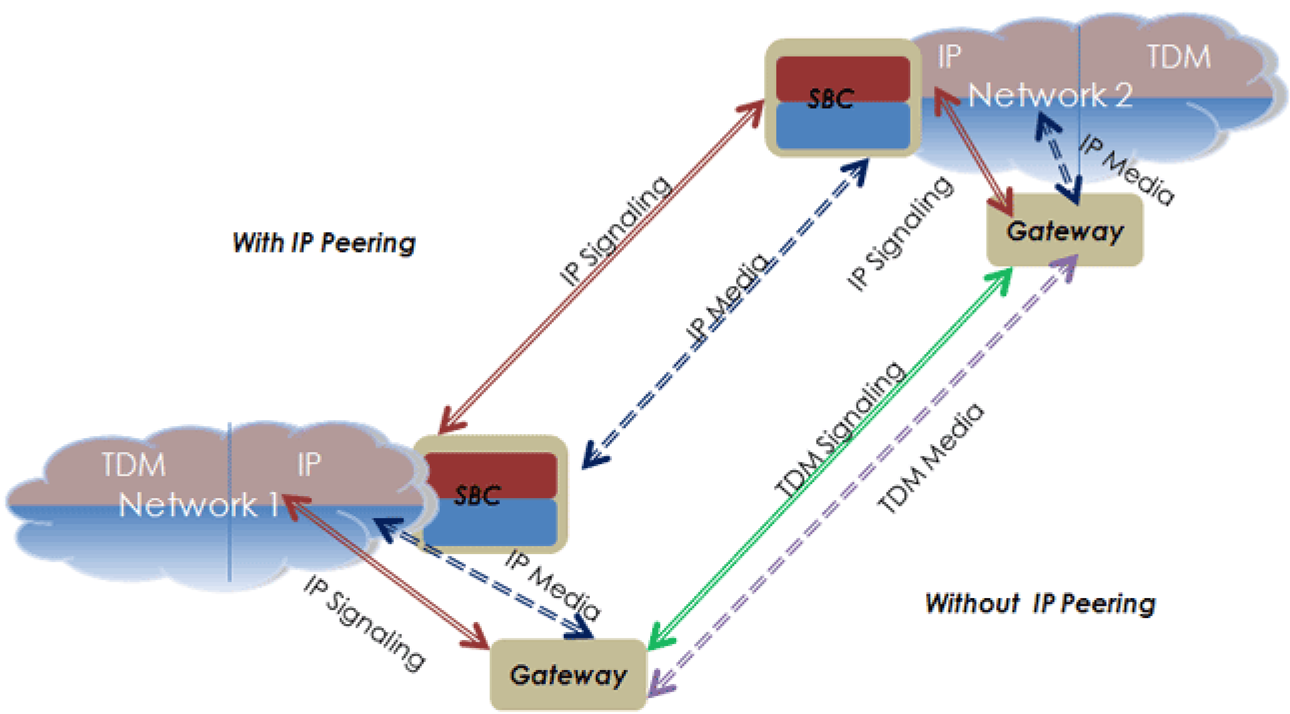
As noted earlier, most IP services rely on SBC capabilities in some form. Therefore in this section of the white paper, we consider how the various models will impact the SBC evolutionary path. In order to accomplish this we utilize six use cases:

- IP peering
- Hosted VoIP
- IPv6 interworking
- VoLTE
- RCSe
- Third-party applications

Use Case 1: IP Peering

IP peering, as shown in **Figure 4**, possesses a strong business case and delivers measureable network efficiencies. This is due to the ability for network operators to deploy IP peering between their networks, allowing them to communicate via SIP directly, thereby negating the requirement to deploy an additional gateway to perform the transcoding of signaling and media planes between IP and TDM. This in turn reduces operational costs associated with leased facilities, minimizes network delay, and potentially decreases the adverse impacts of voice quality associated with having to transcode IP voice into PSTN codecs such as G.711.

Figure 4: IP Peering vs. TDM Interworking



Source: Heavy Reading

While IP peering is a mature and technically straight forward service, looking ahead, the increased penetration of IP will have considerable impact.

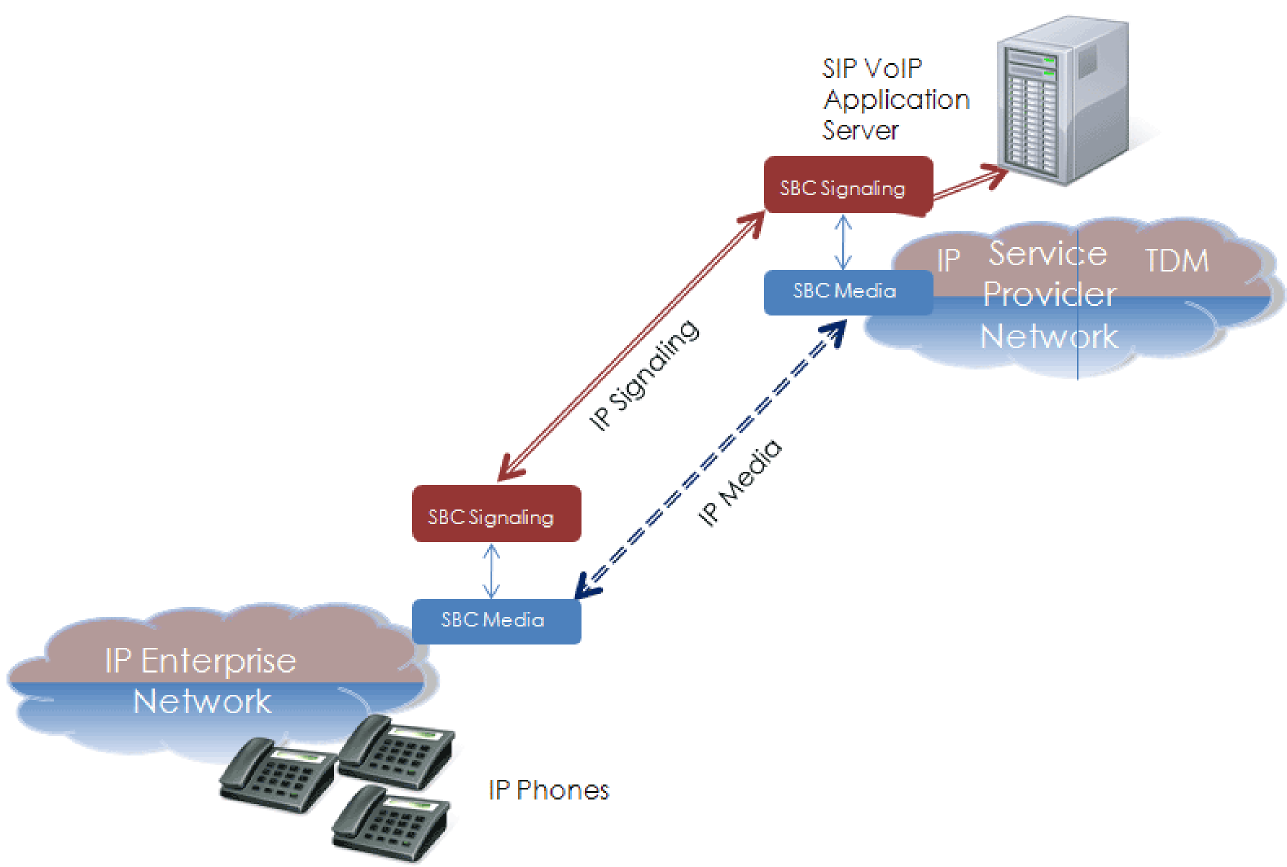
IP Peering – Summary of Future Challenges

Considerations include dealing with the impact of more intelligent devices including additional signaling and media traffic associated with peering IP multimedia services. Peering with LTE-based IP networks will introduce a new set of challenges including meeting the QoS requirements of high status data users. As well since mobile to mobile peering has never been performed at the levels anticipated as carriers build out IMS cores new interoperability requirements will likely be introduced for SBCs.

Use Case 2: Hosted VoIP Services

Hosted VoIP has been a staple offering from operators for a number of years. In this architecture, as shown in **Figure 5**, the network operator manages the VoIP infrastructure necessary for call routing and termination on behalf of end users.

Figure 5: Hosted VoIP Services Reference Architecture



Source: Heavy Reading

And as with all the use cases in this section, we anticipate additional growth as customers look for inexpensive solutions for replacement of TDM infrastructure.

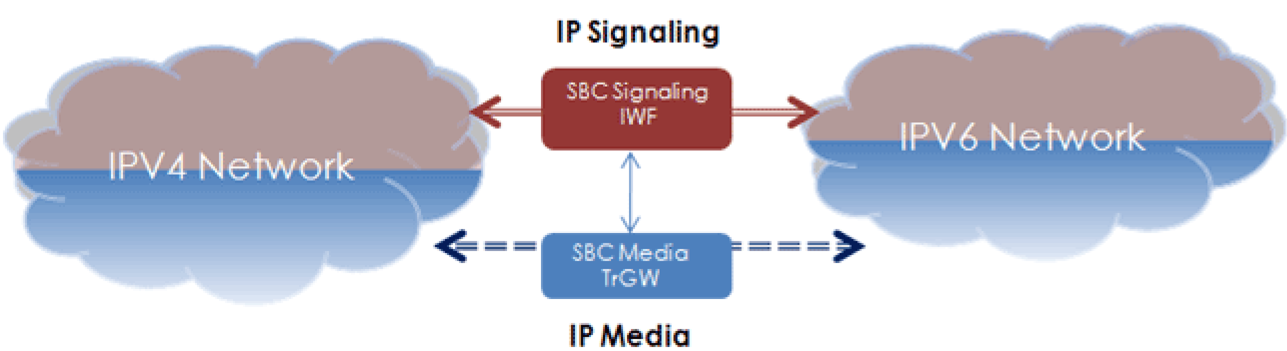
Hosted VoIP – Summary of Future Challenges

While a mature service offering, there is still considerable potential for challenges associated with scaling the SBC to support more SIP endpoints as the mass adoption of IP in the enterprise occurs. Some of the factors to consider include requirements to manage device registration and SIP message manipulation driven by variances in device implementation.

Use Case 3: IPv6 Interworking

With the formal exhaust of IPv4 addresses in mid 2011, the industry is focused more than ever on interworking between IPv4- and IPv6-enabled networks. In this use case, the SBC also plays an important role. Specifically, as shown in **Figure 6**, the SBC provides the IWF and TrGW functionality to support IPv4-IPv6 interworking by screening and translating destination IP addresses as required.

Figure 6: IPv4-IPv6 Interworking



Source: Heavy Reading

While IPv6 interworking may be conceptually relatively straightforward, the implementation is highly complex.

IPv6 Interworking – Summary of Future Challenges

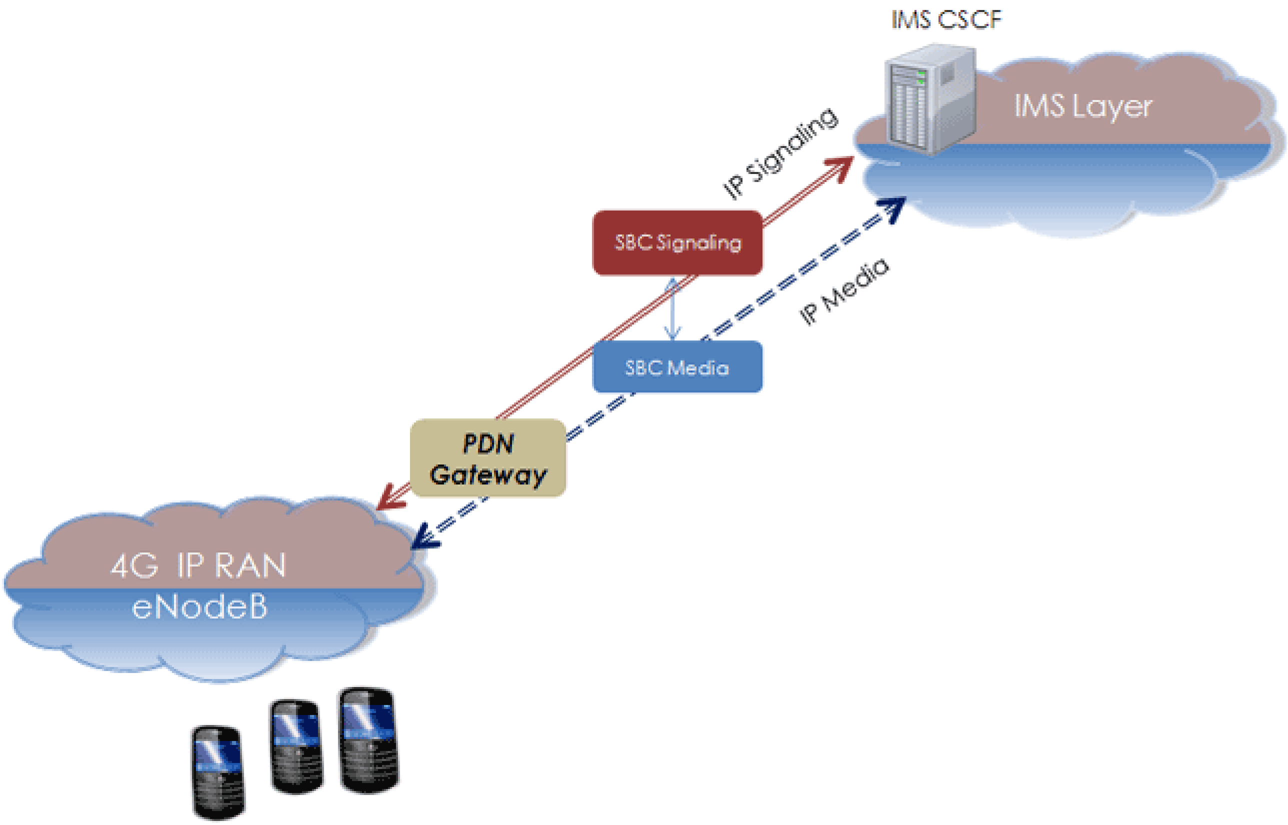
Even though networks may share common core and access network technology, as they start to support both IPv6 and IPv4 addresses, there is no guarantee that applications will continue to function normally given many applications were written assuming an IPv4 address structure.

Use Case 4: Voice Over LTE

After many years of planning, 4G LTE access networks are now being deployed to support end-to-end delivery of IP voice and data services. As part of this migration, the industry has reached consensus that the most effective means of supporting IP mobile voice calls is utilizing voice over LTE (VoLTE), as shown in **Figure 7**.

Since this approach assumes the presence of an IMS core, the SBC by design plays a key role. For example, in VoLTE, the SBC supports the P-CSCF and various interworking control functions for managing on-net termination of SIP-based voice calls between IMS based operators.

Figure 7: VoLTE Reference Architecture



Source: Heavy Reading

VoLTE – Summary of Future Challenges

Since LTE coverage will take a few years to reach commercial mass, interoperability of different vendor core implementations will take some time. Since the SBC is both signaling- and media-centric, modifications to both planes may be required.

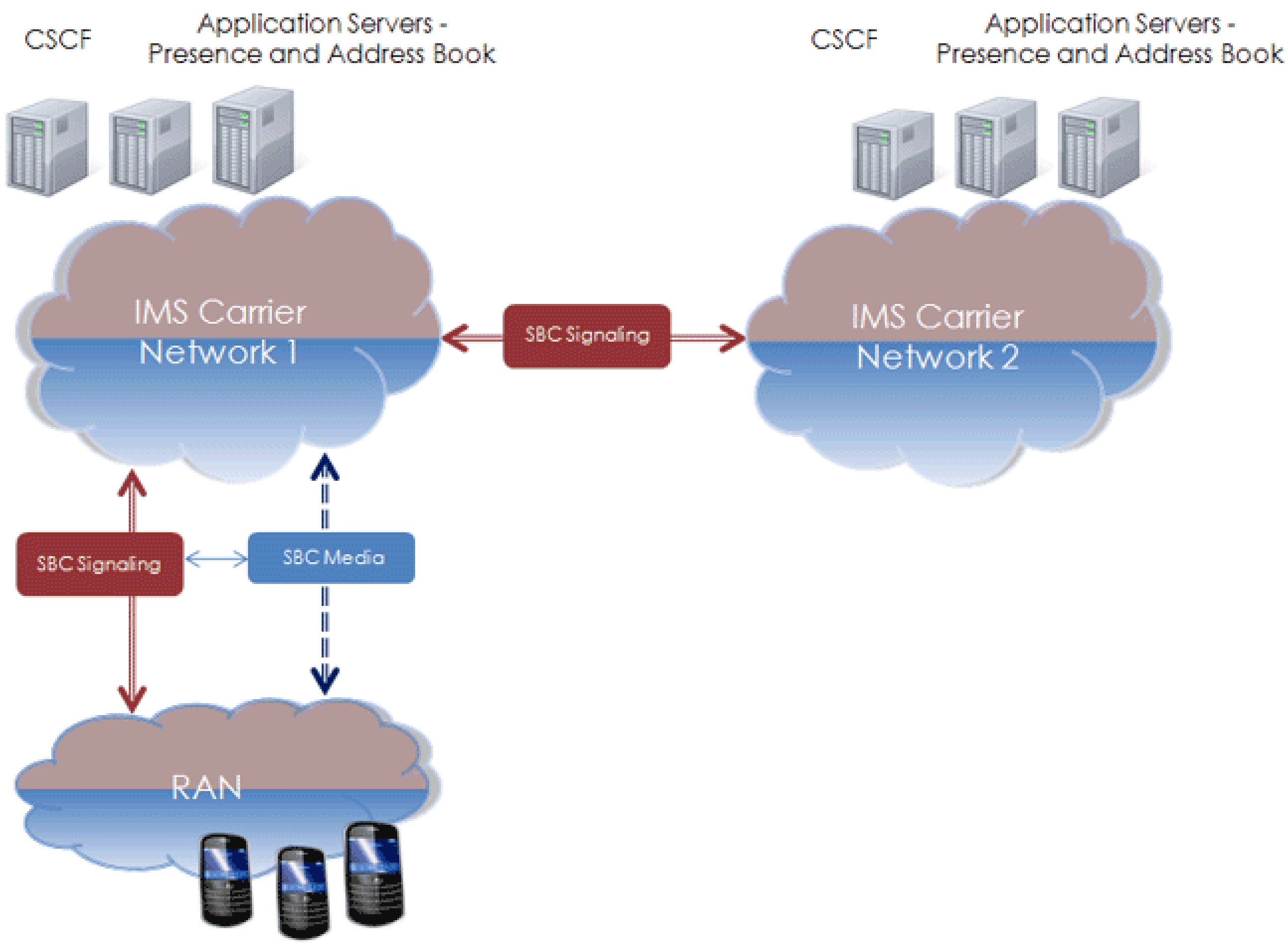
Given that initially most VoLTE calls will be off-net, SBCs will require greater performance capacity to support signal and bearer transcoding to facilitate call delivery to legacy fixed and mobile networks.

Use Case 5: RCSe

Rich Communication Suite – enhanced (RCS-e) is an industry initiative led by the GSMA to support interworking of key voice and text functions across IMS networks, as shown in **Figure 8**.

By building these functions into IMS and mobile device address book clients, the intent is to provide users with a consistent user experience for sharing presence, messaging, video and other content data in real-time by ensuring data transfer is simplified while avoiding multiple application log-in scenarios.

Figure 8: RCSe Reference Architecture



Source: Heavy Reading

RCSe – Summary of Future Challenges

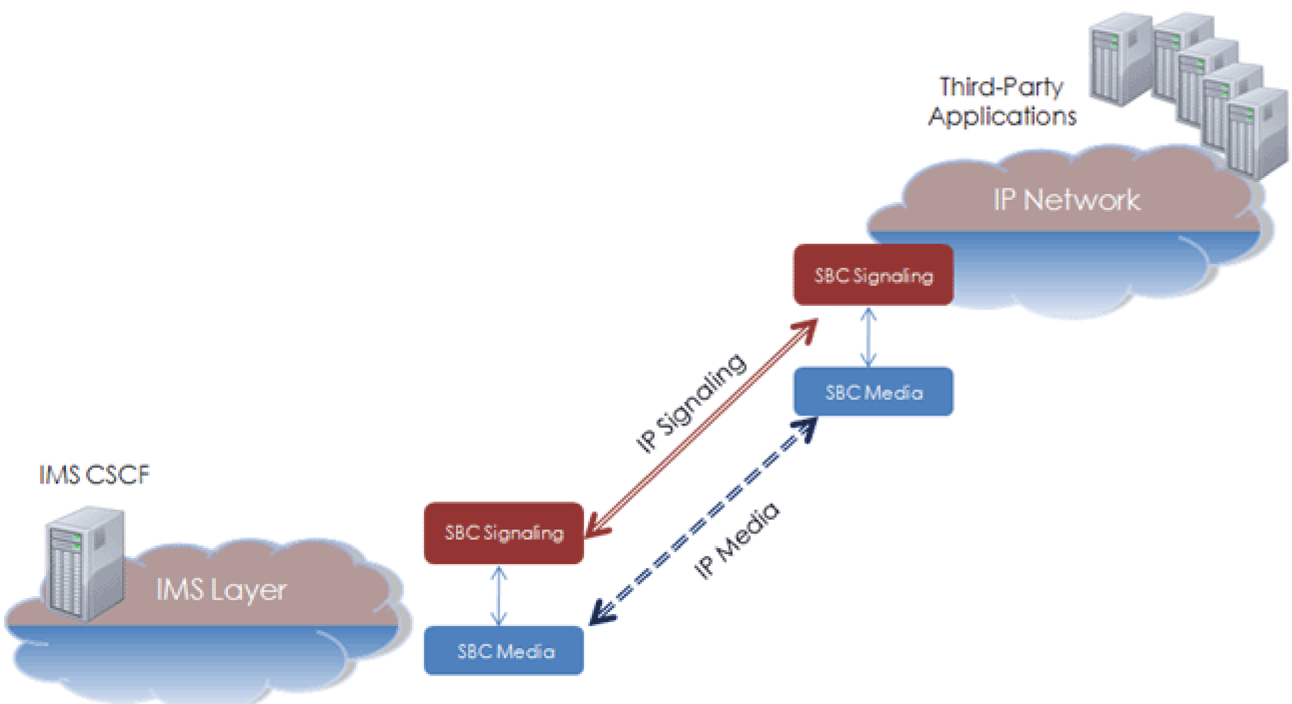
RCSe networks will require extensive interworking to ensure initial RCSe services such as address book perform as expected and the service experience is consistent across the two networks. The additional signaling requirements associated with running concurrent sessions must also be factored.

Use Case 6: Third-Party Applications

In this final use case, we consider an emerging scenario for IMS services delivery. Given network operators are looking for new strategies to defend against over-the-top applications, through leveraging their IMS deployments, operators are now considering the options including the potential to integrate third-party SIP-based applications, as shown in **Figure 9**. In this approach, the third-party application is considered a SIP Application Server which resides in another network.

One of additional benefits of this model is that is can be leveraged to support the introduction of a two-sided billing model. The value proposition of this model for telcos is that they can continue to charge customers for content, while creating a new revenue stream by charging application developers a fee to gain access to the subscriber base.

Figure 9: Third-Party Applications



Source: Heavy Reading

Integrating Third-Party Applications – Summary of Future Challenges

There are several challenges to consider. First this approach will drive additional signaling session and admission control requirements. In addition, monitoring QoS performance of the application will need to be performed by the SBC.

Conclusion & Summary

In a relatively short period of time, the SBC has established itself as a critical component of next-generation fixed and mobile networks. And looking ahead, we believe the overall relevance of SBCs will continue to grow in the years to come. However, it is also becoming readily apparent that this growth and the latest trends in service delivery will present new implementation challenges for SBCs going forward.

As a proof point, in this white paper we have documented that new emerging use cases such as RCSe, VoLTE and support of third-party applications are intrinsically more complex, introduce new requirements, and therefore necessitate that SBCs utilize an optimized and flexible design to maximize scalability potential.

Background to This Paper

Original Research

This *Heavy Reading* white paper was commissioned by Metaswitch, but is based on independent research. The research and opinions expressed in this report are those of *Heavy Reading*.

About the Author

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Jim Hodges has worked in telecommunications for more than 20 years, with experience in both marketing and technology roles. His primary areas of research coverage at *Heavy Reading* include softswitch, IMS, and application server architectures, protocols, environmental initiatives, subscriber data management and managed services.

Hodges joined *Heavy Reading* after nine years at Nortel Networks, where he tracked the VoIP and application server market landscape, most recently as a senior marketing manager. Other activities at Nortel included definition of media gateway network architectures and development of Wireless Intelligent Network (WIN) standards. Additional industry experience was gained with Bell Canada, where Hodges performed IN and SS7 planning, numbering administration, and definition of regulatory-based interconnection models.

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