



The 10 That Established VoIP



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September 2007

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About The Project

VoIP represents a major paradigm shift in communications technology. It is changing business processes and consumer lifestyles worldwide. Not only is the change over to VoIP irreversible, VoIP has proven to be the main catalyst in convergence of services and networks. And yet, there is no documented recognition of the contribution made by the companies that established this industry. Although the contribution of varying nature and importance came from numerous organizations, a few among them stand out in the crowd. They have been the chief agents of this change, the paradigm shift. Through this booklet iLocus intends to document this important chapter in communications history which could otherwise remain unarticulated.

Our method of selection of the 10 most influential organizations in VoIP history is straightforward. We examined the VoIP market from 1996 onwards and listed certain critical developments in the industry that helped establish it. We then correlated those developments with several selected companies that played a part in those developments. Table below explains this in detail along with the shortlisted companies. We have not necessarily selected one company per 'Development'. That would have been just too mathematical.

	Development	Details	Companies Shortlisted
1	Articulating the concept of telephony over Internet	Although transporting voice over data networks had been achieved before, articulating the possibility of telephony over Internet was a critical conceptual development	Vocaltec, Clarent, Vienna Systems, IBM, Net2phone
2	Interworking of VoIP with PSTN	PSTN was ubiquitous. IP had to interwork with PSTN for VoIP to get started. The hardware and software engineered for this purpose was the next big leap	Audiocodes, Cisco, Net2phone, Nuera, NMS
3	Making cross network (IP/PSTN) telephony a commercial service reality	Early IP-PSTN application in form of PC-to-Phone had to be a commercial reality for VoIP to march onwards	Net2phone, iBasis, Deltathree
4	Establishing VoIP and displacing TDM in ILD networks	Today nearly 40% of ILD traffic is VoIP. This major shift was brought about by a handful of ILD VoIP wholesalers.	ITXC, iBasis, NTT Communications, Deltathree
5	NLD class scalability in VoIP systems	Marching further on from ILD into NLD networks, now the VoIP technology was about to compete head to head with legacy switches. A couple of switch makers stand	Sonus Networks, Nortel, Lucent, Convergent Networks, Telica,

		out in the crowd here.	Santera
6	Making NLD class VoIP a commercial service reality	Driven by the need to reduce transportation costs and armed with ownership of large IP backbones, a handful of service providers took the leap forward to transport large scale voice traffic over IP network, thus inducing confidence among large carriers	Level 3, Genuity, DataVon, Global Crossing
7	Facilitating adaptability and migration strategy for incumbent service providers	Incumbents still own majority of the network assets. VoIP still presents both opportunities and threats for an incumbent. In order to adapt accordingly, a stable migration strategy had to be facilitated by the legacy vendors as well as the startups.	Nortel, Lucent, Sonus Networks, Telica, Santera, Tekelec
8	Connecting VoIP islands IP-IP	Secure IP-IP peering was a critical development in expanding the VoIP services and footprint, while at the same time reducing the IP-PSTN conversion costs.	Acme Packet, NexTone, Kagoor
9	Establishing large scale retail VoIP services	Apart from the limited scope of PC-to-Phone, VoIP had not directly benefited the consumers till 2002/03. The proliferation of broadband thereafter was no doubt the key factor in the success of retail VoIP, however it took the efforts of a few companies to get retail VoIP cemented	Skype, Cisco, Vonage, Softbank BB, Fastweb, Avaya
10	Extending VoIP across all networks (fixed and wireless)	With the IMS and FMC, VoIP is no longer restricted to just one network or service. VoIP is now catalyzing a converged network facilitating services across all domains. A few known companies have contributed in taking VoIP to this advanced state.	3GPP, Kineto Wireless, Ericsson

Having shortlisted candidates, we discuss why the company has been selected over others in its particular area, contribution made by the company that established benchmark for the industry, key personnel who worked at the company on important issues in those times, challenges they had set themselves and how they solved them. We will also briefly discuss the company background, main VoIP developments over the years, and the present market status of the company.

The emphasis will be on (1) contribution made by the company in establishing VoIP, and (2) the reasons why the company was selected over others in its particular area.

1. VocalTec

Back in 1995 there was some elementary form of voice being transported over data networks. Within the Internet applications, there was Internet Relay Chat (IRC) where users could chat with each other. So one could argue that VoIP, in a way, did exist before VocalTec. However back in 1995, IRC did not do VoIP in real-time. IRC was a meeting place mostly for text chat, and half-duplex/one-way voice chat. VocalTec's PC-to-PC VoIP application was the first software solution which allowed users to have real-time full duplex voice communication over the Internet.

Product named Internet Phone, developed by VocalTec, was a pioneering product from two aspects: (1) It had the ability to do VoIP call over the bandwidth-starved public Internet of 1995, and (2) The developers of Internet Phone had to overcome the limitations of the hardware of that time which comprised of 486 based PCs and modems of 28.8 kbps speed.

Unique contribution here was to achieve real-time voice, including compression, with the standard PC hardware of 1995, and enable users to talk over public Internet in real-time. That was a major breakthrough that VocalTec achieved. The company developed a proprietary voice codec called VocalTec Compression Codec, which compressed voice at 7.2 kbps. Including the IP overhead, it was feasible to work with 14.4kbps modems as well.

Apart from Internet Phone, the first ever IP-PSTN breakout gateway was also introduced by VocalTec. The company demonstrated the first gateway at CT Expo in Los Angeles in the March of 1996. VocalTec was also the first to introduce RAS (Registration Admission, and Status) Version 2, a gatekeeper element that allowed creation of inter-domain type networking by using RAS protocol as part of H.323.

So these three – Internet Phone, breakout gateway, and gatekeeper element - would be the main pioneering contributions made by VocalTec in VoIP industry.

VocalTec also made several contributions to H.323 standard later on. The company had to initially create its own VoIP standard called the Internet Phone Protocol. From Internet Phone Protocol the company later migrated to H.323 and established some of the features that made possible the splitting of gatekeeper functionalities from gateway, and enable secure calls to go between two networks in an inter-domain type scenario. The initial gateway and gatekeeper functions came in form of an integrated solution so there was just one box that combined control and transport functions.

There is no other company that can be associated with pioneering real-time voice over Internet. So that makes the job easy for us. VocalTec was the first in introducing PC to PC VoIP client and hence is selected as one of the 10 organizations that established VoIP. There were other competing companies that were working on such projects who introduced similar solutions subsequently. These included Nuera, Net2phone, Cisco, Clarent, Vienna Systems etc.

In terms of which company introduced the first breakout gateway, there were companies like Net2phone and iBasis working on it internally and with other vendors like Cisco, NMS Communications, and Nuera. There were at least a dozen different companies working on the solution. But their gateways all followed those introduced by VocalTec. As mentioned above, VocalTec demonstrated the first gateway at CT Expo in Los Angeles in the March of 1996. It was a one line gateway, which enabled PC to Phone and Phone to Phone application over the Internet. There was no other breakout gateway prior to that. The partner that brought in the hardware module for the product was Dialogic. VocalTec developers built a module that was plugged on top of Dialogic board to handle echo cancellation. Since the hardware was not capable of full duplex conversation, VocalTec simply used two channels in order to create one duplex channel of real-time VoIP. Using two channels of the board VocalTec developers built an additional mezzanine card on top of it to handle echo cancellation and compression for a voice call. The name of the Dialogic card was D41E.

The two founders of VocalTec, Alon Cohen and Lior Haramati, founded the company in 1989. In the early days at VocalTec they worked mostly on soundcards (even before SoundBlaster made its mark in this area) for PCs. Around 1993, company called ClassX was merged into VocalTec. ClassX was working on voice over packet networks. Initially it was voice over IPX and other packet networks (non-IP) common in enterprise networks at the time. The initial product that was born out of this was an early version of IP PBX which did voice over LAN (VocalTec LAN) and WAN (VocalTec WAN). Around late 1994, the company discovered that IP was going to be bigger than other packet networks. So the company set out to make VoIP-over-WAN solution for enterprises with multiple branches. VocalTec built a hardware oriented solution for VoIP over WAN, with a hardware card that the company designed internally. From there on, the company set out to weed out the hardware part. So instead of implementing the compression algorithm, echo cancellation etc on hardware board, the company tried to accomplish this with software. Once VocalTec was able to develop a pure software solution, it was able to distribute the software over Internet instead of having to ship boxes. It was this shift from hardware to software which brought about the Internet Phone product to the market. The members of the development team that built the Internet Phone application were:

Alon Cohen

Lior Haramati
Opher Kahane
Ofer Shem-Tov
Late Elad Sion
Dror Tirosh
Rami Amit

Internet Phone downloads were not in millions as is the case with hugely popular Internet applications nowadays. However in early/mid nineties there were not many Internet users around. And the product also came at an initial cost of \$59.99 per license. Downloads were in tens of thousands. At that time cost of the international calls was very high and people found it amazing to be able to make free international calls. The product was initially sold over the Internet and later through major stores in the US. Internet Phone application was actually one of the first e-commerce software products i.e. a software product that was sold over the Internet.

At some point the telecom industry would have utilized VoIP but most probably at a later phase. The launch of Internet Phone created significant hype which in effect helped create an industry segment. The hype element came from the fact that the international calls in 1995 were very expensive. With VocalTec's product, users could call internationally for free. Among the early users of VocalTec's pioneering product were journalists who generated a huge media attention around this new product.

In absence of VocalTec, the VoIP application is likely to have been developed (1) at a later phase, and (2) probably not for direct use of consumers. This is obviously just a guess. Had the client side of VoIP not been developed first, it is likely that VoIP would have found a breeding ground in niche areas such as CTI, or maybe something like a breakout gateway enabling phone-to-phone application might have made its way into the market first. This is one of the scenarios. If that had happened the industry would have grown at a lot more slower pace because the hype element would not have been there. Again, it was the users of early Internet Phone – some of them journalists and Internet enthusiasts – that helped create significant media attention around VoIP because of the price differential between a free call and the existing international long distance charges. The hype element is often ignored by the industry players and even sometimes blamed for VoIP woes. The hype element was in fact a main driver of VoIP in its early stages.

2. Level 3

VoIP at Level 3 started in 1997 with an internal project on inter-working of SS7 and IP. Among those who worked on the project was Ike Elliot who later made significant contributions to MGCP standard. The project aimed to separate control and media elements for IP data traffic and was initially named as SIOS (SS7-IP Operating System) project. Sometime during 1998, SIOS was renamed as Softswitch. It was the Level 3 team that actually coined the term. Apart from the term Softswitch, other VoIP product names that are generally used today also have their origin in the early Level 3 VoIP project. Some of them include 'Media Gateway', 'Trunking Gateway', 'SS7 Gateway' etc etc.

In the April of 1998, Level 3 acquired Cambridge, Massachusetts based XCOM. The two companies had been jointly working on softswitching element for dialup PRI traffic. In December of 1998 Level 3, with the help of the acquired technology and in-house work on SS7-IP, launched service to handle dialup modem traffic for service providers. The service rationale was to ease the switch congestion that occurred due to dial up Internet traffic. Level 3 technology was able to divert the Internet dialup traffic from TDM voice switches to a modem bank, the softswitch. The key was to be able to separate control and media so that the cost and scale of the platform could be controlled.

Although the initial application for Level 3's SIOS/Softswitch project was dialup modem traffic handling, voice was the main motivation behind the project. The company recognized voice as a potential target market. Voice continued to be the king in late nineties. However Level 3 was looking to do voice in its own way, the IP way. In order to avoid huge TDM switch costs, the company decided to purchase disaggregated switch which was of course not available off-the-shelf in those times. Lucent and Nortel were asking for tens of millions of dollars for such a custom platform. Level 3 decided to develop the platform in-house. By disaggregating, ports became modem banks and intelligence was shifted over to inexpensive server software that utilized standard hardware. Thus by disaggregating, Level 3 was able to achieve a lower cost for the platform.

Year 1998 also saw the standardization of MGCP protocol. Level 3 brought in the IPDC part while Telcordia contributed the SGCP part. Together the constituent parts made up MGCP, which was endorsed by IETF and today forms a critical component of overall SIP stack. The IPDC technical advisory council later transformed into the Softswitch Consortium, one of the most influential VoIP industry forums up until a few years ago. The Softswitch Consortium renamed itself as the IMS Forum which remains an influential industry body.

After successfully engineering the 'data softswitch', Level 3 started work on the voice side of its softswitch product. In March 1999, Level 3 made the first VoIP call using its internally developed softswitch platform. In the December of that year (1999), VoIP saw the first large scale Domestic Long Distance wholesale service launched. Up until then, VoIP had been confined to two main applications: PC-to-Phone and international long distance wholesale. Shortly after the Level 3 platform was equipped to handle voice, the market downturn started. VoIP at Level 3 took a backseat for a while till 2002/03 when Level 3 renewed VoIP investment. During the downturn (2000 till 2002), dialup modem traffic grew exponentially on Level 3 platform. VoIP enhancement resulted in universal port gateway technology development which helped Level 3 launch one of its post-downturn VoIP service, the local inbound service. So Level 3 continues to utilize its internally developed VoIP platform.

We have selected Level 3 (as one of the 10 organizations that established VoIP industry) for its important role in defining standards such as MGCP. It's work in the area of softswitch has no parallel among the service providers. No other service provider in the history of VoIP has contributed so much to VoIP technology. The company accelerated the deployment of VoIP domestic long distance wholesale service in the industry. It played a dominant role in transitioning VoIP from international long distance wholesale to national long distance wholesale. Large scale softswitch deployments were not known till Level 3 came up with its offering.

We think that in absence of Level 3 contribution, standards would have been different. SIP would have been weaker. The VoIP market would have developed a little slower since none of the large carriers and incumbents were venturing into a large scale VoIP deployment around 1998/99. When Level 3 launched the domestic long distance wholesale offering based on VoIP in 1999, the platform combined voice as well as data, and could handle up to one billion minutes per day. This was a giant leap for VoIP.

3. ITXC

I have chosen ITXC among 'The 10 That Established VoIP' for the company's pioneering contribution in the areas of International Long Distance (ILD) VoIP wholesale model, management of voice transportation over public Internet, commercial interoperability among varied VoIP platforms, and VoIP peering.

ITXC (which is now part of VSNL) began service in April 1998. One of the initial investors was its equipment supplier, Vocaltec. Along with Elon Ganor (the then CEO of Vocaltec) and Tom Evslin (CEO and founder of ITXC), person named Michael Spencer (at the time working for Booz Allen, later joined TrulyGlobal – a spinoff from Vocaltec - as CEO) wrote the initial ITXC business plan. As much as ITXC would subsequently resist its classification as a 'clearinghouse', the fact is that the initial business model was to operate as a broker for numerous VoIP POP (Point of Presence in form of a VoIP termination gateway connected to public Internet) owners worldwide. ITXC however swiftly moved over from broker model to wholesale model in order to improve its margins. The fact that it did not have to lease lines to offer wholesale services made the change over to new model much faster. It meant however that ITXC either installed or co-owned a significant number of POPs around the world.

ITXC consolidated traffic in the US and terminated into highly regulated places. Three factors played into the success of ITXC: regulatory bypass, inherent cost efficiency of transporting voice over public Internet, and being able to get a partner POP operational within hours. Once the company was able to establish itself in the US, it then started origination outside of US.

Working with a vast group of VoIP POP owners (ITXC itself owned a large numbers POPs) induced competition among these termination partners which in turn resulted in more competitive rates than what companies like AT&T had access to. This kind of wholesale model was totally new. At AT&T which also had an ILD wholesale offering going, it took a long time to put up a voice interconnect with a corresponding carrier. And the interconnects would always be with traditional carriers in different countries.

Even with a company as big as AT&T, you would have interconnect agreements only with a handful of service providers, while as ITXC had direct interconnects with hundreds of POP owners around the world, owing to open IP access to gateways over public Internet. That was something unknown in the old wholesale model.

So, to what extent did ITXC pioneer the model? Well, ITXC was not the sole pioneer of this model. There were others like iBasis. However I think that ITXC contribution in propagating this model from marketing

perspective was greater than the contribution made by others. ITXC articulated the new wholesale model much more than the others. If you were a POP owner at the time, the first company you would think of as your minutes supplier would have been ITXC.

The second most important contribution that ITXC made (and iBasis again was not that far behind here too) was the technique developed to tame the public internet for transportation of voice. Over time, ITXC and iBasis, evolved a sophisticated call routing technology that helped route voice over bandwidth-starved internet. Although the technology is not used today but it was critical at the time when bandwidth was scarce. In absence of such technology, VoIP would not have taken off at the scale it did in late nineties.

Third major contribution: ITXC played a big role in improving VoIP equipment indirectly. Networks such as the one operated by ITXC were test beds for early VoIP vendors from which they benefited a great deal. Bringing scale and robustness to VoIP platforms was something ITXC facilitated in practice. I would say, in terms of scalability of VoIP traffic (and hence the platforms), ITXC contribution on the service side was second only to Level 3. Level 3 did it on the domestic long distance side, while ITXC did it commercially in the area of ILD.

Fourth major contribution: ITXC had big influence on interoperability. It facilitated the first commercial interoperability between Cisco, Clarent (now Verso) and Vocaltec.

Fifth major contribution: ITXC also led the market in terms of the new IP-to-IP peering voice internetworking model that is engineered today using session controllers.

So let me revisit the question 'Why ITXC and why not the other eligible company, iBasis'. As mentioned above I think (1) ITXC articulated the new Internet telephony wholesale model much more while iBasis was initially more focused on managed IP; (2) In the area of technology iBasis did not contribute as much as ITXC did: areas such as interoperability standards. iBasis operated a single network from the outset; (3) In VoIP interconnect, on the service side, ITXC played a much more prominent and active role as compared to iBasis.

ITXC, along with iBasis, was a significant catalyst in forcing the Accounting Rates down worldwide, thus making international calls affordable. Accounting rates came down because international wholesale VoIP became a reality. And international wholesale VoIP become a reality due to companies like ITXC and iBasis.

4. Sonus Networks

By 1999, the first phase of VoIP miracle had been achieved. People could make international calls for a fraction of the cost they previously paid. Companies like Vocaltec and ITXC had made significant contributions in making that happen. The next big thing in VoIP was pushing packetization to the trunk level. But the vision varied in the industry.

Service providers at the time had two choices: either continue using public Internet to transport national long distance voice traffic, or somehow re-engineer their own networks to become compatible with the data-voice convergence trend. The first option was simply not good enough because there was not enough IP bandwidth to transport high volumes of voice traffic. VoIP technology also was not mature and scalable enough to handle high volume voice traffic. Service providers therefore began a long march toward a re-engineered PSTN.

And there were several players around who bet on this move. Among them were Transmedia, IP Cell, IP Verse, Oresis, Santera, Telica, Convergent Networks, Sonus Networks, Rapid 5 Networks, EmpowerTel, Salix, Cisco etc. The legacy vendors also offered enhancements to their existing TDM switches.

The high density gateway and softswitch technology that these companies developed for the purpose is really the cornerstone of the re-engineering of public networks that is taking place around the world. It represented a giant leap for VoIP: from international arbitrage application to a robust carrier grade switching system. Had such carrier grade systems not been engineered, VoIP would not have developed the way it has.

The company that contributed the most in this significant industry development in VoIP history is Sonus Networks. Sonus has been a leader in changing the public network. Along with the vendors mentioned above, Sonus also built carrier grade media gateway and softswitching technology. The reason it made a more defining contribution comes down to a few factors that I have identified:

(1) The telecom equipment heavyweights were focused more on preserving their TDM footprint. Nortel and Lucent offered migration solutions in form of enhancements to the existing switches. This was not a compelling offer for service providers at the time. (2) The competing startup vendors like Telica and Santera were effectively looking to build cheaper circuit switches and package them with the IP interface. (3) Other competing vendors (which included some startups as well) were focused on RAS type platforms that integrated dial-up traffic. Since the dial-up traffic was a declining application (due to proliferation of broadband), the platforms failed to get much traction. (4) Cisco, which would have given Sonus the toughest time decided to focus on enterprise VoIP.

Sonus stayed clear of the universal port gateway trend. The company built its solution as IP from ground up. It optimized its product around PSTN-to-IP type of voice flow. In the process, it played a bigger role in transformation of public networks than any other equipment vendor.

In absence of Sonus, I think there would have been a delay in the deployment of VoIP trunking. The RAS type platforms would never have prevailed. In absence of Sonus, the service providers would have continued with slow deployment of patch enhancements from legacy vendors. Either that, or (possibly more likely) they would have bought more TDM switches.

The initial VoIP application was arbitrage, using mostly the public internet for transporting voice. Technologies available at the time were not scalable enough. Sonus' founders came to their own conclusions as to where the industry was headed. And its assumption was that public network itself was going to swap out; that service providers would take advantage of this new technology; that data already had started to swamp the communications network, and broadband was expected to be deployed widely; and that the voice networks would follow this trend as well. Based on those observations Sonus set out on a different set of assumptions about what a product needed to look like. The company set out to enable service providers to swap out their own infrastructure. For example the company saw that the fundamental voice codec that would be used would be G.711, straight 64k voice channel instead of highly compressed voice. The company optimized its solutions around G.711.

So if Sonus recognized that data and voice were going to merge in the public network, why did the company not come up with a multiservice kind of switch or maybe a universal port gateway? Why did the company instead develop a voice focused gateway? Even though one of the earliest customers of Sonus was Level 3 that did huge business with the likes of AOL and others on the dial-up side, Sonus believed that broadband networks were going to be deployed widely and dial-up would be a declining application. Sonus decided not to develop universal port gateway solution. Cisco, Commworks and others did. They got some early wins. But it was a declining application. And Sonus has proven itself to be right.

In the area of RAS based universal gateway products, Nortel offered CVX dialup platform. Cisco has AS5000 series. Lucent had TNT. These companies tried to couple in IP voice technologies but they did not scale. They also trifled with ATM based solution. Cisco introduced MGX which is based on their Transmedia acquisition. Lucent had a couple of ATM products from Cascade days that they tried to add some voice on. But that failed. And Nortel had put voice on their PVG gateway which again was an ATM core product.

We may attribute some of the success to the fact that during the downturn, Sonus did not have many financial problems like the incumbent vendors did. It had plenty of cash and time to focus on technologies it was developing. The company went public in May 2000 and raised about \$100 million. There was a major secondary offering as well. Its startup competitors on the other hand did not get an opportunity to tap the public markets on time either.

Nevertheless, if we look at late 1990s and early 2000s, Sonus was already enjoying more success in VoIP trunking deployments compared to incumbent vendors like Lucent and Nortel. I guess Nortel was a bit slow with their 'Succession' strategy, and it represented just a disaggregated form of the earlier product. But Lucent did have some trunking gateway, and so did Cisco. And there were other high density players like Telica etc. However it must said that Lucent was in serious disarray especially in the early days when they were trying to push through three different NGN solutions. They were not focused on one particular solution. Sonus on the other hand was focused on one solution. Another factor is that if a legacy player is focused on preserving what already exists as opposed to enabling what should exist, then what you fundamentally get is a sub-optimal technology. Obviously Nortel and Lucent tried to pitch for migration of their customer base. They were effectively preserving their infrastructure, not really focused on enabling new applications. Sonus' success has depended on a view different from preservation. As a result, Sonus has had success in greenfield accounts, and even Nortel and Lucent accounts, while as Nortel and Lucent have had limited success only in their old accounts. Nortel and Lucent are not winning in each other's accounts either.

5. 3GPP

In order to justify our choice for selecting 3GPP among the 10 most influential organizations in VoIP history, we have to start with answering two straightforward questions: (1) How far is 3GPP responsible for drafting IMS blueprint, and (2) What role has IMS played in promoting VoIP?

Question 1 is easy to answer. 3GPP as a forum is wholly and solely responsible for drafting the IMS blueprint. There was no particular member (out of the usual suspects there such as Nokia, Ericsson, Motorola, but also companies like Huawei, LG, and RIM) whose contribution to IMS was the outweighing one. As with other standardization forums, 3GPP standards were developed by consensus. IMS standardization was a concerted effort. It would be fair to say that the credit should go to 3GPP as a forum of members rather than an individual member.

Before attempting to answer question 2, it is important to note that IMS is based on SIP, and IP in general. As such, promoting IMS, directly promotes VoIP. Prior to IMS, VoIP and NGN in general had been around for a long time but no one had done much standardization work around it. IMS represents the first industry wide NGN technical standardization. And IMS acceptance represents VoIP acceptance. So our question 2 then rephrases itself as follows: How far has IMS been deployed in the industry. Answer to that question will determine the importance of 3GPP contribution so far.

We have heard of over hundred IMS service provider trials worldwide but no service provider in the world can claim to have deployed a fully IMS compliant network serving all its customers. Nevertheless what is important is the momentum IMS has gained in terms of service provider trials and vendor compliance. For the last three years no one in the industry has questioned the fact that move toward VoIP is irreversible. Having said that, only 5 percent of the world telecom voice networks has migrated to IP. And yet VoIP already represents a major paradigm shift in communications industry. Likewise, the IMS blueprint implementation (although IMS blueprint is far from 100% complete) also seems irreversible now. This is reflected in the long term commitment to IMS from the vendors as well as the service providers.

I hope to have convinced you so far that (1) 3GPP as a forum of members should be given the credit for drafting IMS rather than giving credit to an individual forum member, and (2) IMS standardization is a major industry development that directly promotes VoIP.

Let us now move over a slightly lighter discussion on IMS and 3GPP. IMS was originally meant for cellular networks. Even in the late nineties it seemed inevitable that networks would migrate over to packet switched architecture. So that was the motivation for the IMS blueprint. IMS was all

done within 3GPP as cellular activity until about three years ago when ETSI, the ITU and ATIS of North America started discussing NGN together. NGN had been around for a long time but no one had done much standardization work around it. There was no reason to reinvent the wheel. 3GPP had done all the ground work. The committee decided to 're-use' the IMS spec. The decision was firmly supported by ETSI TISPAN which was the most advanced NGN standardization group at the time. At the same time, VoIP was mostly a public internet affair and quality sub-standard. So the first challenge that the 3GPP faced was how to re-orient basic SIP to introduce QoS concepts found in TDM world. The real serious development of IMS commenced in release 5 which ran for couple of years from 2000. But it was finished off in release 6 and some improvements had been done to it in release 7 which is being completed now.

A vast majority of IMS specification was network orientated and was access independent. So it was equally applicable to fixed networks. Indeed it is now being re-used in PSTN and cable networks. And of course equipment providers prefer to supply the same piece of equipment to various different operators. It was particularly in the interest of equipment providers to use a standard that could be replicated in both wireless and wireline world.

Requirements for fixed as well as wireless carriers are more or less identical because the challenges faced by wireline operators are the same as those faced by wireless operators. Other than regulatory issues related to issuing operator licenses etc, within a relatively short space of time we will see that the functionality of wireline networks will be identical to those of wireless networks. Within the next ten years any distinctions that remain will be artificial. That is true at network level as well as at the end user interface level. Within Europe even the regulatory issues will be irrelevant and there will be no distinction between mobile and fixed operators.

There is another reason why service providers have rallied behind IMS. Service providers have always wanted the intelligence to be centralized so that they have more control over the network, and remain relevant in the new communications industry. Service providers want more control of networks and the revenue streams so that they have the ability to charge their customers. They are reluctant to change their economic models. But most large operators will know that they have to change their economic models. IMS is a necessary step in retaining at least some control over the services delivered over the network.

I will conclude here by mentioning two more reasons why we selected 3GPP among 'The 10 that Established VoIP'. One is the nature of standardization itself in competitive markets. In simpler old days of monopoly telecom operators, standards no doubt took a long time to get drafted but they were drafted by a handful of nominated bureaucrats. In an IT oriented competitive market, standards are decided by the market

share. It is the kind of culture that has evolved over time. Standards therefore take a long time to iron out, and at times the whole process can create market deficiencies and bottlenecks. The fact that 3GPP got all major forums and service providers to agree upon IMS specifications, is quite an achievement.

And lastly: You may well ask why 3GPP and why not the likes of IETF and ITU. Well, the latter two have also made major contributions to VoIP, but (1) IMS is much more significant a development than say G.729 and MGCP standards, and (2) ITU did not, for instance, play as important a role in promoting a certain codec as compared to the role 3GPP played in IMS acceptance; And likewise IETF did not play as important a role in SIP and MGCP specs as compared to the role 3GPP played in IMS specs.

6. Cisco

Cisco created demand for VoIP in the enterprise segment as opposed to responding to the demand. That is what sets it apart from the rest. The company has been involved in an everlasting period of educating the enterprise customers on the benefits of converging their voice and data networks. No other company in the industry has spent as much time and money in this regard as Cisco has. That to me is its biggest contribution to VoIP.

But that is not the only contribution. Cisco has influenced VoIP industry a great deal right from the mid nineties. Cisco provided termination boxes for International Long Distance wholesale. That was the first phase of VoIP success which Cisco participated in through the most robust mid-sized VoIP gateway hardware of mid/late nineties that it offered. Cisco gateways had clear preference over all other boxes. They were not intelligent but they were the most robust boxes around.

Cisco put VoIP in the enterprise networks. The company has effectively created the enterprise VoIP market. Most other large players in that segment are involved in migrating their customers to IP. So they have the customers and they are upgrading/migrating hem over to the new voice solutions. Cisco on the other hand has come from nowhere to become the largest IP PBX and IP Phone supplier to the enterprise.

Cisco also nurtured the ATA development. No major telecom equipment maker, other than Cisco, ever considered ATA significant enough. ATAs have played a pivotal role in getting the consumer VoIP going. Cisco's commitment to ATA products have indirectly pushed Voice over Broadband (VoBB) penetration worldwide.

In general, Cisco commitment to VoIP has meant a lot for the industry. Whether it is internal innovation or acquisitions or investments in startups in this area, Cisco has shaped VoIP to an extent which no other company has. In Cisco, VoIP found an established and a successful company genuinely promoting VoIP. It was obviously in the interest of Cisco to do so if the company had to make its mark in voice business. Being a data equipment company, it did wonders. It leveraged its position in the data equipment market exceedingly well, moving its customers towards converged networks.

In absence of Cisco, I think VoIP international long distance wholesale would not have progressed as quickly as it did. The first generation VoIP vendors were focused more on software. When legacy vendors joined along with the second generation VoIP vendors, they were focused more on high density gateways. There was a time gap of at least three to four years between the two attempts. Had the Cisco gateway product not

served in the interim, we would not have witnessed as many changes in the international long distance market as we have.

In the enterprise segment, VoIP would have been limited to hybrid PBX systems and probably occupied in addition by very small startups that would not have had the channels into the enterprise. Consumer VoBB would also not have progressed as much as it has, had Cisco not been there. Commitment to VoIP technology from a large company was necessary for large carriers and enterprises to try VoIP. Customers need to make sure that their suppliers are going to be around for a long time. In absence of Cisco's participation, VoIP would still be struggling to come of its infancy.

7. Skype

Skype is easily the most influential consumer offering that the VoIP world has been able to produce in its history of 13 years. Let me list the reasons why I think Skype was successful where others, who came before Skype, failed. Skype was successful because:

(1) Skype used a peer-to-peer architecture. This reduced call set up time and the general service downtimes. Skype's peer-to-peer architecture for Internet telephony is more efficient than a traditional telecom provider's network or VoIP providers because it does not need central servers or central resources to scale. Skype's marginal cost is zero for each call and the cost of adding new users to Skype is less than \$0.01.

(2) Skype initially licensed GIPS' ILBC (Internet Low Bit-rate Codec), a royalty free codec. Skype also used variable bitrate wide-band codec from GIPS. The latter adjusts for bandwidth starved conditions on public Internet, and if it spots a lower bandwidth connection on one side, it automatically negotiates down to ILBC. For PC-to-PSTN termination, ILBC is used and transcoded over to G711 etc by the termination gateway. GIPS codecs were specifically designed for voice over public internet. Comfort noise generation, echo cancellation, voice activity detection: all these elements have to be balanced – within the bandwidth constraints - in order to produce the desired voice quality. GIPS codec dynamically balances the elements depending upon the bandwidth available. In short, GIPS has played a part in enhancing the voice quality of Skype. But it surely was not just GIPS codecs that made the quality better than that found in previous PC-to-PC VoIP clients.

(3) Skype came to market when broadband had taken roots. Broadband penetration is a fairly recent phenomenon. High speed Internet connections started to scale some five years back. In the late nineties the number of broadband (both DSL and cable internet) subscribers was miniscule, although things had started to move earlier in countries like South Korea and Japan. In general speeds in mbps were certainly not common. Skype got started in 2003, and by this time consumers were giving up their dial-up connections in favor of broadband. In that sense Skype's launch timing was perfect. And that is the biggest reason for its success.

(4) Prior to founding Skype, the founders were involved in another successful P2P venture called KaZaa. Skype did not directly leverage the KaZaa user base to drive customer acquisition. KaZaa was in fact sold to Sharman Networks in January 2002 and Skype was born around August 2003. Skype and KaZaa are two separate companies. However the founders and the new service did not require any introduction by any means. In fact KaZaa at that time (and still is) the most downloaded

Internet client. It has had over 380 million downloads so far. Skype is the second biggest with over 220m as of end June 2007.

(5) Skype's did not experience the type of pricing pressures that previous PC-to-phone service providers had to face seven years ago. Looking at PC-to-phone service history, Net2phone struggled for a long time with its PC-to-Phone business. Dialpad had to undergo re-organization. There were also PhoneFree, Deltathree, and Mediarling. Just prior to the downturn, these companies were forced to offer a free version of PC-to-Phone because of cut throat competition. The race was on to sign up as many users as possible. However there was a fundamental flaw. The revenue model did not work. It was based on advertising and turning the brand into some sort of a portal to cross-sell other things. And we all know that those models also failed. Skype in comparison has been lucky not having to experience such pricing pressures.

(6) Then there is obviously the snowball effect. Success breeds success. Everyone wanted to work with Skype. Skype started working with a variety of hardware companies that offered a number of third-party hardware accessories which worked with its software. The early partners included Plantronics and Logitech headsets, CyberPhone K USB phone, and the Olympia Cordless DUALphone etc. The ecosystem of Skype partners today is astounding. These hardware partners co-marketed "Skype Ready" Bluetooth headsets, dongles, USB phones, speakerphones, and other hardware devices. Device partners working with companies like Net2phone and Deltathree had to effectively work with their suppliers such as Cisco and others while as Skype directly published its APIs for developers.

These factors combined made sure Skype was a bigger hit than the previous softphone based VoIP offerings. Let me now turn over to the stuff relevant to us i.e. what has Skype contributed in VoIP to put it in the top 10 list of companies that established the VoIP industry. Following is the list of contribution according to my understanding:

(1) Skype introduced VoIP to consumers on a large scale. Although over 35% of world's international calls and over 12% of world's national long distance are transported over IP network, the process is largely not transparent to the end user. Those who 'consciously' use VoIP i.e. knowing that their voice calls are being transported over IP networks as opposed to traditional TDM networks, is a small number in comparison. It is less than 300 million worldwide including ATA based VoBB users. Out of that number, over 220 million people use Skype. There is no doubt some overlap, but that perhaps sums up Skype's contribution to VoIP.

(2) Skype restored the original glory of VoIP i.e. a softphone led revolution. Had VoIP been confined to hard broadband phones, it would have not created much change. Softphone led VoIP is much more

powerful and Skype played the biggest role in that. That in my opinion is Skype's biggest contribution to VoIP market.

(3) Voice is bound to become just another application over a multimedia network of the future. The biggest push to voice in that direction – at service level – has come from Skype. The company has done that without serving the mainstream telephony user base. In fact it has actually not attempted to serve the mainstream which is what most VoIP providers like Vonage did. By remaining Internet oriented (rather than telephony oriented), Skype has created a major shift in voice communications industry. The resultant push will facilitate an even stronger pull from the Internet world, thus adapting voice as an application in the overall multimedia communications context. In that sense Skype phenomenon has been more disruptive than the combined efforts of all the VoBB service providers like Vonage, Fastweb and Softbank.

(4) And lastly, Skype's mega acquisition was a major leap for VoIP industry. It made VoIP hot again among the internet startups. VoIP had finally arrived.

Skype's selection to the 10 (that established VoIP industry) is an easy one. I cannot think of any company that has contributed as much as Skype did in the areas that I have identified above. The closest ones that I can think of are ... none!

8. Softbank BB

Voice-over-Broadband (VoBB) breathed a new life into VoIP. A few companies stand out in terms of their contribution toward making that happen. These, in my opinion, include Cisco and NetCentrex on the equipment side, and Softbank BB, FastWeb and Vonage on the service side.

Among the service providers, it was Softbank BB that lit the match driving everyone to react. Softbank BB was able to highlight to the market that a higher access bandwidth was the main bottleneck keeping VoIP at bay, and that VoIP technology otherwise was mature enough to sustain a large scale consumer offering.

The Softbank BB case has been the single most potent driver for the launch of VoBB services worldwide. It was the first major 'test lab' for consumer VoIP telephony. Nearly every deregulated country now has multiple VoBB offerings available. VoBB created a major disruption in the market. Incumbents started losing phone lines to VoBB services driving them to launch their own offerings. That has basically shifted the whole telecom world towards VoIP.

The reasons I have chosen Softbank BB rather than Vonage or FastWeb are simple. Softbank BB was the pioneer in VoBB services. Vonage and FastWeb came in a little later. Vonage contributed more from the marketing perspective raising awareness of VoBB in general, while FastWeb played a more defining role from the triple play perspective.

VoBB is all set to replace POTS. But five years back when Softbank BB launched its VoBB services, not many people were convinced this was the way to bring VoIP to the edge. The industry had bet on Class 5 switch replacement rather than a hosted telephony model which Softbank BB was pursuing. Within just seven months of launching the service, Softbank's VoIP offering had signed up over a million subscribers. Today there are near about 15 million VoBB subscribers in Japan, a country that has been very enterprising with regard to VoIP.

9. NexTone

With the softswitch offering, VoIP industry had heavily focused on IP-PSTN call flow. Not many were focused on call management within the IP cloud. NexTone was one of the first companies that looked at this problem. That is one area where NexTone was the innovator and a thought leader. The company pioneered the Session Management terminology in the industry.

NexTone was set up to serve the CLEC industry, offering solutions for enterprise VoIP. When the CLEC industry quickly vaporized during the downturn, the company was left with IP-to-IP focused technology that it leveraged into a Session Border Controller (SBC). At this stage the international long distance operators in the US using VoIP interconnected via TDM. They would convert VoIP back to TDM and handoff to another VoIP operator who would then re-convert it back to VoIP. As such back-to-back gateways were being used. NexTone understood the gateway technology well and decided to simulate those two back to back gateways in software. So that was the genesis of SBC. This was a significant disruption. The resultant solution reduced VoIP interconnection-related Capex by one-tenth.

Those developments took place around 2001. There was nobody else working on the problem at the time. There were companies like Aravox but they were focused more on security aspect of VoIP peering. So that is the background to NexTone's SBC development. With regard to the other SBC players, Acme Packet, the present market leader in SBC, was building a programmable firewall around this time. Their bet was that there were services like VoIP that would need to be dynamically programmed. That was their genesis. Kagoor started as a bandwidth management kind of solution. Netrake came from deep packet inspection background. They built custom ASICs to go and look into different levels of a packet. And there were couple of others also.

NexTone spent a huge amount of marketing dollars and energy along with Acme Packet and others on the education they had to provide to the industry on the significance of SBC as an essential component. Now the industry realizes that SBC is an important standalone product.

Going back to the discussion related to NexTone's contribution, while working on removing the back-to-back gateways, NexTone stumbled upon the interoperability problems. VoIP carriers were (and still are) using different protocols/gateways or two different versions of the same protocol. NexTone was the first one to provide SIP-to-H.323 interworking.

If we look at the sequence of problems in carrier-to-carrier VoIP peering, the first issue was getting rid of back-to-back gateways; the second one was interoperability; third one was security which was mainly about

topology hiding on both sides; fourth one was QoS and SLA across network elements of two different carrier networks. NexTone was the first company to address all these issues. The company was also the first one to introduce the concept of dynamic policy management.

NexTone has also been a pioneer in distributed SBC architecture, using off-the-shelf hardware for SBC, and adding intelligence at the edge. If we take NexTone out of the picture, we would not have seen so much drive in the industry to enhance intelligence at the edge. In absence of NexTone we would likely have seen a lot dumber looking SBCs at the edge of the network. There was also the desegregation of signaling and media elements that Nextone started which was later picked up by Kagoor and Acme Packet and also companies like Newport Networks.

Another factor is that SBC as a product has had a bigger influence in carrier-to-carrier VoIP peering than carrier-to-consumer/enterprise peering. The whole interconnection model and carrier wholesale model stands challenged by carrier-to-carrier VoIP peering. And in the carrier-to-carrier VoIP peering space NexTone has contributed much more than the other SBC vendors.

NexTone was established in 1998 by Raj Sharma and Sridhar Ramachandran, both of whom worked for Hughes Network Systems. The 1996 Telecom Act in the US had led to the creation of a large CLEC industry. There were innumerable number of CLECs and the investment climate was also favorable if your product was geared towards the CLECs. The big debate at that time was whether voice should be carried over IP or DSL. In late nineties there were vendors like Jetstream and Tollbridge who bet on DSL. Nextone's bet was on IP: convergence of voice and data over IP network.

The initial solution from NexTone was a VoIP system for CLECs who in turn would sell services to enterprise. The solution was essentially server architecture inside the network and IAD type devices deployed at the customer premises. A similar product today would be Cisco 2600 for enterprise and for residential customers the ATA. The server in the core would process the calls and do the termination. So it was a kind of low end softswitch for CLECs. Unfortunately the whole investment scenario for CLECs changed very rapidly in 2000. NexTone at this stage had about 11 customers. There were several bankruptcies among the CLECs.

NexTone was left with technology that it leveraged into an SBC.

At this stage NexTone explored the next big problem in VoIP. There were plenty of resellers in the US that did not require licenses to operate. These resellers did not have to comply with regulatory issues like CALEA and 911. They were independent operators selling calling cards for instance, and essentially doing international long distance. These service providers were using VoIP but the only way they interconnected was via TDM. That

is how NexTone got involved in developing technology for IP-IP interconnection that evolved into today's SBC.

10. SpectraLink

In absence of the wireless component, VoIP cannot claim to be an all encompassing communications technology. Obviously the wireless aspect is important for VoIP. In Voice-over-WiFi, the predominant form of wireless VoIP, perhaps the main and the outweighing contribution came from handset vendors because that was the main new component required to make Voice-over-WiFi possible.

Access Points that interoperated with them had to just recognize voice packets and prioritize them, which is now a standard function for a switch. There was not much to be done on PBX or the call control side. There might have been a slight bit of tweaking to make PBXs receptive to wireless VoWiFi handsets. But in establishing VoWiFi the handset vendors are the main candidates if we are to shortlist the most influential companies in VoWiFi. And the handset vendors included SpectraLink (now part of Polycom) and Symbol, and later on Cisco. Cisco was rather late to the market. They entered the market in 2003.

Lowe's Home Improvement, the retailer in the US, was the first SpectraLink customer that demanded a converged voice and data WiFi network. The main hitch was the lack of QoS mechanism within the 802.11 standard at the time. SpectraLink set out to develop open standards compatible QoS mechanism, Spectralink Voice Priority (SVP). SVP was a defacto standard in VoWiFi industry while 802.11 standards body was working on the QoS standards. What this did was, it allowed the VoWiFi to get into the market early. The other aspect the company worked on was the enterprise phone system integration.

Before 1999, there was no standard in place for VoWiFi. The initial 802.11 WiFi standard had just about come out at that time. There was ongoing work for solving problems like security etc. There were other priorities rather than voice component within the standardization body. A lot of vendors still use SVP but there is migration toward 802.11e.

The first VoWiFi phone handset that SpectraLink announced was named NetLink. SpectraLink announced it in 1999 at the Interop show. The company did not have its own booth there. The product was displayed at various partner vendors which also exhibited. At that initial launch the product was showing in the booths of Cisco, Symbol, Proxim, Agere/Lucent.

It was actually Symbol that announced the VoWiFi handset first. In terms of deployment, however, Spectralink was ahead of them. If we compare the contribution between Symbol and SpectraLink in the area of VoWiFi, we have to consider that: (1) Symbol leveraged VoWiFi phones to sell WiFi infrastructure solutions; (2) Symbol did not show much commitment to VoWiFi handsets exiting the business around 2004; (3) Symbol did not

spend as much effort promoting VoWiFi and educating the enterprises about the technology as SpectraLink did. Spectralink was the primary voice of VoWiFi for several years; (4) Although not a criterion in our selection of companies in this list, compared to symbol SpectraLink had more wide scale deployments. Very quickly it became the market share leader and it never lost that position.

I think that in absence of SpectraLink there would have been a significant delay in deploying VoWiFi. The fact that SpectraLink was an independent phone vendor, it helped drive standardization between VoWiFi phones and other relevant network components like PBXs and switches.

I also think that in absence of VoWiFi technology, convergence of wireless and wireline networks would have taken a different route. In the nineties we had convergence of PSTN and cellular through some IN type technology. The predominant FMC technology that vendors like Alcatel, Ericsson, and Nortel had was essentially analogous to femtocell concept we see today where we have deployment of smaller base stations using cellular technologies tied back into centralized controller at the customer premises. The reasons why those solutions never took off are twofold. One is that these systems were expensive to deploy. The other reason is that they created a headache for the service provider in terms of having to deal with provisioning and figuring out which channels will be allocated to it.

If we did not have VoWiFi, we would see service providers still taking a swing at FMC through the old type IN approach. And femtocell deployments are indicative of that. What WiFi brings us is a robust broadband, high-capacity, voice-ready technology that enterprises are going to deploy anyway on their own. Enterprises do not depend on service providers to bring in this solution. WiFi is unlicensed and unregulated which makes it easier to deploy than traditional cellular technologies.

In terms of competing technologies for WiFi, there is also DECT. DECT radio technology is, however, more TDM based. It does not form part of end to end IP. DECT does not extend into supporting convergence of voice and data. WiFi does. Other competing technologies for converging voice and data on enterprise networks would be 3g and Wimax. But for those the jury is still out. WiFi is a reality in enterprise networks today.

APPENDIX: Thirteen Years of VoIP: 1995-2007

1995-1996: Introduction of PC-to-PC VoIP Application

Transportation of voice over data networks had been achieved before 1995. However what the introduction of 'Internet Phone' software client did in 1995 was to articulate the concept of telephony over Internet. That caused a lot of excitement because the users could place a one-to-one call for free over long distances. The first company to articulate this concept was Vocaltec. 'Internet Phone' was the first PC-to-PC VoIP application marketed as a direct competition to traditional telephony. It was a software application that allowed voice conversations over the Internet between users logged on simultaneously. In addition to the Internet access, the user required a multimedia PC. Multimedia elements in 1995 used to come separately and were not part of a standard PC. Specifically the user required speakers, microphone, soundcard, and the Internet Phone software in order to use the application.

The user could place calls anywhere in the world to other Internet Phone users at the cost of a local call because for the amount of time the user was on the Internet he/she was paying at a local call rate since the Internet access was through PSTN dial up back in 1995. The main sales channel for the PC-to-PC VoIP application were the ISPs who bundled the software to boost their ISP business. The ISPs thus promoted PC-to-PC VoIP application in its early years.

The PC-to-PC VoIP application proved to be a new competitive threat because there was a large price differential between a local and an international call. In the US where the local calls are not metered, the international calls made via the VoIP application were free. So the international calls revenue of PTTs were at risk. The PC-to-PC VoIP application also competed directly with International Simple Resellers (ISR) and the Callback operators of those times. The advantage of PC-to-PC VoIP was that it bypassed the age old Accounting Rate System which was a cartel type arrangement through which incumbent monopoly carriers used to compensate each other for excess international traffic i.e. if carrier A sent carrier B (both carriers based in different countries) X million minutes and received Y million minutes from carriers B, then carrier A would have to pay a set Settlement Rate for each of the excess traffic minutes X-Y. Settlement Rate was half the set Accounting Rate.

Carrier in developed world were at loss due to VoIP because they faced international call substitution. Carriers in the developing world that were net receivers of the international traffic generated a lot of revenue through the Accounting Rate System. So both campaigned against the new PC-to-PC VoIP application. In face there was a petition by the American Carriers (the ACTA petition) that called for the ban of PC-to-PC VoIP application. In certain countries, regulators acted against VoIP. In the US and various

parts of Europe, regulators saw in VoIP a small but growing source of competition. They let it flourish.

1996: March Onwards from PC-to-PC VoIP

PC-to-PC VoIP application was introduced by Vocaltec in 1995. Within just one year, having realized that PSTN was ubiquitous and IP limited, VoIP developers found a way to interconnect IP with PSTN for telephony. PC-to-Phone application was introduced in August 1996 for the first time by Net2phone. Developers established relationships with hardware vendors to achieve IP-PSTN interworking. Vocaltec teamed with Dialogic (later acquired by Intel), Net2phone teamed up with NMS Communications, and iBasis partnered with Cisco. The results was a PSTN breakout gateway or a media gateway.

It took no time for the developer community to introduce a phone-to-phone VoIP gateway, which meant that the user did not have to access Internet via PC in order to enjoy the benefits of low cost telephony over IP. VoIP based service providers cropped up everywhere.

1996-1999: Early VoIP Media Gateway Market

Media gateway was the first commercial VoIP product that vendors made some money on. Early media gateway manufacturers included Vocaltec, Nuera (acquired by Audiocodes), Vienna Systems (acquired by Nokia), Cisco, Clarent (acquired by Verso), and Ascend (acquired by Lucent). Their target market was the long distance carriers and 'termination POP owners'. Termination POP owners were the partners of carriers who took IP voice handoffs off the Internet and terminated the traffic into the local PSTN wherever their POP was.

Apart from including VoIP optimized silicon, media gateways used protocol stack like H.323 and SS7. The gatekeeper element (H.323 term) which is essentially the call controller was integrated with the early media gateways. The gateway and gatekeeper in VoIP split up in 1997/98. However you will still see integrated systems today. So not all VoIP systems follow distributed architecture paradigm.

Media gateways were not in direct competition with the Class 3 switch market or the international telephony switch market. Over the next three years (1997-2000) VoIP media gateways and gatekeepers were deployed in long distance networks where occasionally they displaced an aged switch, or where the service provider was looking to expand the footprint. The use was limited to prepaid and wholesale long distance applications. A new VoIP wholesale model of long distance service emerged. Along

with that, a clearinghouse model for VoIP also emerged. The wholesalers included ITXC and iBasis etc. Clearinghouses included AT&T Global Clearinghouse, NTT Communications, Arbinet, Telia etc.

1997-1999: VoIP Moves into National Long Distance (NLD) Networks

Once the carriers gained confidence in the usage of VoIP systems in international long distance networks (ILD), they started pushing packetization from ILD POPs towards the edge. The next wave in VoIP market was the deployment of VoIP in national long distance network (NLD). For this to happen, scale needed to improve dramatically. Gatekeeper was a rather passive brand for a large scale call controller. In 1998, the term Softswitch was born which was essentially a large scale gatekeeper.

Both the legacy equipment vendors as well as the startups worked on making dense, scalable, and robust VoIP based switching fabric and stable large scale IP based call controllers that would support large scale voice traffic. These systems were predominantly for carriers who had large IP backbones which they could utilize better by shifting some long distance voice traffic over those IP networks.

All the legacy vendors set out to build the softswitches. They had better luck with re-orienting their existing switching product, however the carriers were not ready to upgrade their networks yet with IP on a wholesale basis. This was a rather frustrating period for the legacy vendors who struggled to find a place in the new VoIP market. Startups on the other hand had some successes. The startups of this era who build softswitches and large media gateways included Sonus, Transmedia (acquired by Cisco), IP Verse (present day Veraz), Convergent Networks, Rapid 5, IP Cell (acquired by Cisco), Oresis, Santera (acquired by Tekelec), Gluon Networks (acquired by Zhone) etc.

1999/2000: Early Developments in Softswitch Market

H.323 proved not to be scalable for large scale systems. A new Internet style protocol called SIP was adopted by vendors in 1999/2000. Although the new softswitch architecture was based on SIP, there used to be a deep philosophical divide between the SIP and softswitch camps regarding the preferred network architecture for VoIP networks. The underlying SIP vision was that the network core is fast and dumb with intelligence residing at the edges. SIP initially accomplished this by using a peer-to-peer architecture to eliminate the need for centralized network

intelligence. According to the dumb network philosophy, wide area transport just ships the bits. Plentiful bandwidth ensures QoS so that explicit QoS rationing mechanisms are not necessary.

However, that SIP-based dumb network vision did not really succeed. First of all, this approach reduces carriers to mere suppliers of commodity transport. There is no role for them in creating value and capturing margin. It is unlikely that carriers would deploy an architecture that erodes their importance in providing high margin services. Vendors such as Dynamicsoft acknowledged the problem a long time and added modules to provide intelligent SIP-based core routing. Hence SIP kept evolving towards greater network intelligence. The softswitch school recognized that the success of VoIP requires it to be incorporated into a highly scalable internetworking solution that can switch and route traffic and handle protocol conversion between TDM, IP, ATM, frame relay, and other networks. This would ease the adoption of packet switched voice by reducing the need to replace existing circuit switched infrastructure at a time when capital was scarce.

Besides seamless interoperability between heterogeneous networks, this internetworking solution needed to overcome the many failings of circuit switching and its outdated architecture in order to make a good business prospect. The PSTN packages switching and intelligence into physically integrated proprietary Class 5 platforms that used to carry bare bones price tags of a million or over. These switches are expensive to operate and extraordinarily difficult to deploy. In addition, the PSTN creates unnecessary redundancy in network intelligence by deploying these large network 'brains' at every switching node whether intelligence is required or not. As a result, the mesh of highly intelligent switches requires large overhead in network personnel to manage it. Moreover, these Class 5 circuit switches have no open service creation platforms to spur innovation despite the increasingly commodity status of carrier voice offerings. The creation of new services was left mostly in the hands of vendors with long development cycles on proprietary platforms. Finally, from a technology point of view, the 5E was outdated. Developed in the late 70s and early 80s, the 5E has not been revamped to fully exploit silicon economics.

The softswitch solved these challenges. It represented the future of VoIP because it linked the older TDM quarters of the Telecom City to the new packet switched neighborhoods. This seamless internetworking is critical for a world in which IP voice traffic is likely to originate from and terminate on the PSTN for a long time to come. The softswitch fundamentally recognized that legacy and new technologies must be integrated so they are transparent to the end user. Defined by the separation of call control from switching, the softswitch decomposes the functions performed by a traditional Class 5 system into physically distinct modules that can be placed separately in the network. This distributed architecture is not only ideal for internetworking, but also lowers capital requirements and operational costs vis-à-vis the Big Iron switches.

2000-2002: Market Downturn

VoIP had done exceptionally well since 1995 and was on its way to revolutionize telecommunications when the market downturn hit in the year 2000. The first casualty was the free PC-to-Phone service providers who could no longer pay the PSTN breakout charges due to reduced advertising revenues from which they generated their income. Dialpad and PhoneFree are some of the names who come to mind. These companies had forced rivals Net2phone and Deltathree also to offer a free version of PC-to-Phone. So basically with the downturn, the interconnection costs piled up and the revenue models failed.

The ILD wholesale service provider segment had deal with several partner bankruptcies that affected their revenues. On the equipment side, the newly crowned softswitch product line also had their share of blues. To service providers (apart from facing scarce capital for capex spending), there was no distinct value in replacing TDM with VoIP. They had different priorities in the downturn times. There was also no apparent benefit for end user through VoIP networks because the VoIP transportation was transparent to the end users.

Service provider capex dropped dramatically during the downturn. Legacy vendors were in financial trouble, and there were several startup bankruptcies both in the vendor as well as the service provider camp.

2003: VoBB Lights the Match

In pre-downturn times there was a lot of investment in the Internet bandwidth. Companies were expecting Internet applications like e-commerce to take off significantly. That did not happen, but the bandwidth that was laid for the purpose, stayed there. In parallel, broadband connections worldwide were on the increase. These broadband access users had plenty of bandwidth to play with. One of the applications they used was the early PC-to-PC VoIP. They found the quality very much acceptable. Luckily the Analog Telephone Adaptors (that were used during early PSTN dialup times) had evolved to support the broadband interfaces. This meant that the user did not have to use his PC to make quality VoIP calls over the broadband connections.

And so, around the middle of 2003, the telecom world woke up to a quiet revolution that was taking place un-noticed. It happened simultaneously on three different continents. In North America, Vonage was swelling up its Voice over Broadband (VoBB) consumer numbers. In Europe Fastweb Italy became the world's first successful triple play service provider,

offering VoIP, IP PTV and Internet access on the same broadband line. In Japan, Softbank started giving free Cisco ATA to consumer to try VoIP. Softbank signed subscribers in millions. The VoBB success first hit Softbank and later on Vonage and Fastweb.

The industry always believed that broadband was the way to bring VoIP to the edge. It just did not know that such development would be facilitated by small players and ASPs. The industry believed that the incumbent providers had to upgrade/replace the Class 5 switches to bring VoIP to the edge. The industry was proven wrong. The incumbents had to act swiftly to counter the threat of VoBB. They decided to bundle VoIP over their existing DSL broadband networks.

Apart from the bandwidth availability, the factors that made VoBB a success were the affordable telephony packages that bundled local, NLD, and ILD service. Furthermore, in some case TV and Internet was also bundled in. Broadband ISPs and telephony ASPs drove the VoBB market. Incumbents faced line reduction which forced them to offer similar services.

2003-2007: A Period of Maturity for VoIP

Although the telecom spending and capital availability has not reached the levels found in late nineties, the telecom market has bounced back towards the positive territory during the last four years. During this period VoIP matured significantly. The incumbent service providers now have robust migration options available from their legacy vendors, whether it is Nortel, Siemens or some other company. Making incumbents comfortable with migration over to VoIP has taken 10 years. Nearly all large service providers in the world now have a migration plan in place. It can safely be concluded that the shift over to VoIP is irreversible.

Nearly 40% of the ILD traffic is handled by VoIP systems now. There have been numerous Greenfield VoIP deployments of large scale. Apart from migration/upgradation scenarios, VoIP systems are being used in replacement scenarios, hosted VoBB, as well as for increasing switching capacity. And there are VoIP solutions for all those options available in the market today.

End user VoIP in general has progressed leaps and bounds. Millions of VoBB subscribers can be found in several countries around the world. Millions of IP PBX lines are being deployed each quarter replacing the old TDM based PBX equipment. In the enterprise segment both premise based IP PBX and hosted PBX options are available and are being used. VoIP has so far cemented itself more in the enterprise segment as compared to the residential VoIP.

Over the last 3 years service providers have also examined ways to converge the wireline and wireless networks in order to provide single number services across fixed and wireless domains. Although fixed-mobile convergence had been tried before in mid nineties, VoIP provided a better baseline technology to realistically achieve fixed-mobile convergence.

Over the last thirteen years, VoIP has made tremendous progress. There was no doubt some unwanted hype around this technology. However if we take the hype element out, what VoIP has achieved over the last 13 years is nothing short of a revolution.