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Case Study

Cisco India Converges VoIP and PSTN Infrastructure to Increase Productivity and Reduce Costs

Cisco IT Case Study / Network convergence / Convergence of PSTN and VoIP Infrastructure: This case study describes the convergence of Cisco IT's internal PSTN and VoIP network infrastructure in India, part of the Cisco network, a leading-edge enterprise environment that is one of the largest and most complex in the world. Cisco customers can benefit from Cisco IT's real-world experience in this area to help support similar enterprise needs.

"Cisco India IT successfully deployed a converged PSTN and VoIP infrastructure solution that allowed us to reclaim over $1 million dollars in equipment that can be redeployed in new facilities and will result in significant cost savings."
  -- Balaji V., manager, Cisco IT, APAC Network Operations

Background

Cisco Systems® established engineering operations in India in 1996 and has continued to expand its presence to include a number of sites throughout the country, including two Cisco® India global development centers and four Cisco sales offices. Cisco India has also extended its network to serve five engineering partners, three IT applications partners, and one business process outsourcing partner. Together, the network supports more than 4500 users. Because communication is so vital between sites in India and the United States (particularly San Jose, California), Cisco IT extended its global WAN network to connect Cisco India, providing cost-effective voice communications through voice over IP (VoIP) technology. VoIP is an integral part of the Cisco AVVID (Architecture for Voice, Video and Integrated Data), and is supported mainly by the Cisco CallManager, a server that utilizes software-based call-processing on the AVVID network. The software extends enterprise telephony features and functions to packet telephony network devices such as IP phones, media processing devices, VoIP gateways, and multimedia applications.

In deploying VoIP in India, Cisco IT had to adhere to regulatory constraints that forbid the interconnection of VoIP and the Public Switched Telephone Network (PSTN) in India. These rules were established to protect the revenue base of local- and long-distance service providers in India. Enhanced services, such as broadband or Multiprotocol Label Switching (MPLS) are nearly nonexistent in India, and the incumbent local exchange carriers (ILECs) and interexchange carriers (IXCs) must rely almost exclusively on basic telecom services for revenue.

The potential for revenue loss due to PSTN and VoIP interconnection can be seen in the following example. If a residential or business telecommunications customer in India calls a friend or business associate in the

United States, they are routed over the PSTN and pay the toll-call rate. If they were able to use their PSTN phone to access a VoIP network local connection, the VoIP network would carry the call to an exit point in the United States closest to the number they were calling (a technique known as tail-end hop-off), and the call would then interconnect to the local PSTN in the United States. The IXC in India would receive almost no revenue, and the ILEC might receive little or nothing for the local call. Fearing substantive loss of revenue from such arrangements, the telecommunications regulatory body, known as Telecom Regulatory Authority of India (TRAI), established stringent rules against PSTN and VoIP interconnection.

This requirement to keep the voice and data networks separate still allowed three different designs of VoIP (Figure 1). First, businesses could replace their traditional voice private branch exchange (PBX) and voice phones for a Cisco IP CallManager and IP phones, but only if they used their new IP phones to connect through a voice gateway to the traditional PSTN. This relegated the IP telephony solution to an in-building phone system. Still, some customers in India who were building a new phone system or were replacing an aging PBX opted for this design, believing that some day the Indian government would ease regulations and allow them to derive benefits from converging their voice and data networks.

Second, businesses could opt to build an IP telephony system onto their data network, using their corporate WAN to carry all voice traffic between corporate sites. This allowed them to realize some of the benefits of a converged network—including reduced intersite calling costs—but it required employees to keep two telephones on their desk: a corporate network IP phone and an "outside line" traditional phone.

Last, businesses could combine the two systems, replacing their traditional voice phones and PBX with an IP telephony solution, as well as adding IP telephony capabilities onto their data network. This allowed them to migrate away from their legacy phone systems, while still requiring employees to keep two telephones on their desk, since regulations required that there be no interconnections or sharing of devices between the two networks. This also required the business to build and maintain two separate sets of Cisco CallManagers. Still, some customers followed this design, optimistic that the regulations would eventually be eased, and they would be well prepared for a full IP telephony deployment. This was the design that Cisco India deployed. It worked well, and provided many of the benefits of IP telephony, but over time problems emerged—the largest being the inability to combine remote access telephony or remote IP from home with the corporate IP telephony network.

Figure 1. Three different VoIP designs permissible within India, 2004
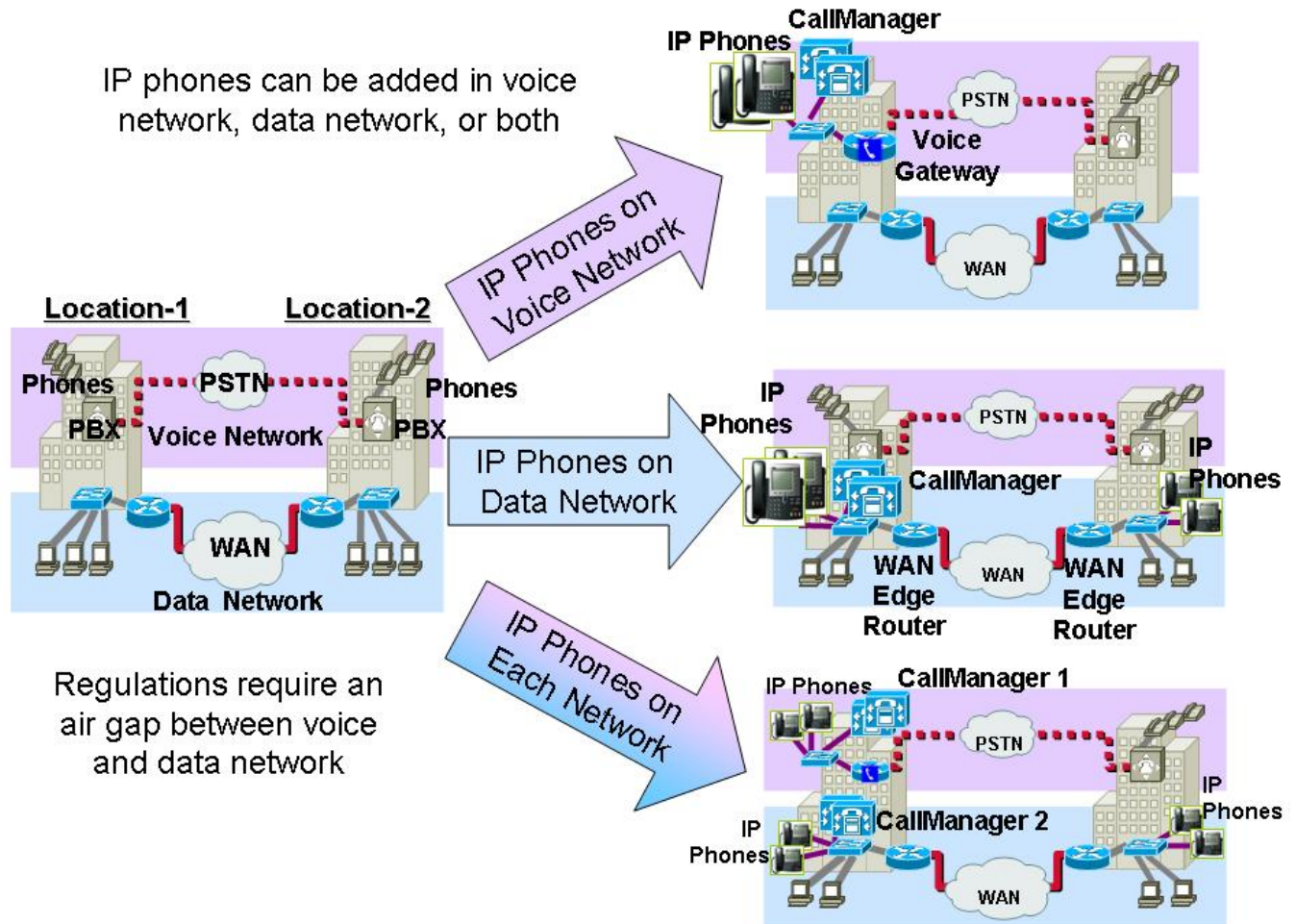
Having employees working in different time zones also poses a problem. Cisco employees in one part of the world might desire to participate in corporate meetings being held in another part of the world, but these meetings often take place in the early morning or late evening for remote employees. Cisco employees in the United States and many parts of Asia and Europe have solved this problem by making a local PSTN call from home into the nearby Cisco VoIP business network, and then using that network to transport the call across the globe. Some employees were also using their home Internet access to set up a VPN connection to their business network, and then setting up an IP telephone connection from home, across the corporate WAN, to a business location on the other side of the globe. Both solutions allowed Cisco employees the convenience of being able to work from home while still being able to participate in meetings and calls with colleagues around the globe.

The 13.5-hour time difference (between Bangalore and San Jose) often made communication between Cisco employees in India and the United States inconvenient. Ideally, employees in Bangalore and San Jose would

be able to call from their home into the corporate network, but until 2001, regulations in India did not allow this PSTN and VoIP interconnection. The alternatives were either to place a long distance call between India and the United States from their home phone at great expense, or to go to the Cisco office at odd hours where they could access the WAN directly.

Cisco petitioned the regulatory body in India to allow an exception to the PSTN and VoIP interconnection rule enabling San Jose managers to call from their home (using a PSTN-to-VoIP interconnection). In November 2001, Cisco IT was given a limited call-center status, which allowed the PSTN and VoIP connection in San Jose and allowed Cisco employees in San Jose to participate in meetings in India from home. This helped reduce telecom costs by effectively utilizing Cisco's WAN backbone network.

Cisco then petitioned the regulatory body in India to allow an exception to the PSTN and VoIP interconnection rule that would allow employees of Cisco India to call offices in the United States from their homes. In June 2003, regulators in India approved a new service called "IN Exchange" that allowed voice calls to terminate at the local Cisco office in India and be carried over the WAN to San Jose. Cisco pays a one-time activation fee of Rs108 (about US$2.50) and Rs 4.25 (about US$0.10) per minute (both incoming and outgoing) per connection to enable this service on the Cisco India employee's residential phone line.

Challenge

Limited call-center status and IN Exchange helped make communication more convenient for some Cisco employees, but did not resolve the basic and most obvious issue created by the restriction on PSTN and VoIP interconnection. Because PSTN and VoIP could not be interconnected, two network infrastructures were needed—essentially two of everything: two phones on every desk, two voice mailboxes for every employee, and two Cisco CallManager clusters. Cisco India employees would use their PSTN-connected IP phone, for example, to call local suppliers, most local partners, or to call home (Figure 2).

Figure 2. PSTN Voice Network Before Convergence
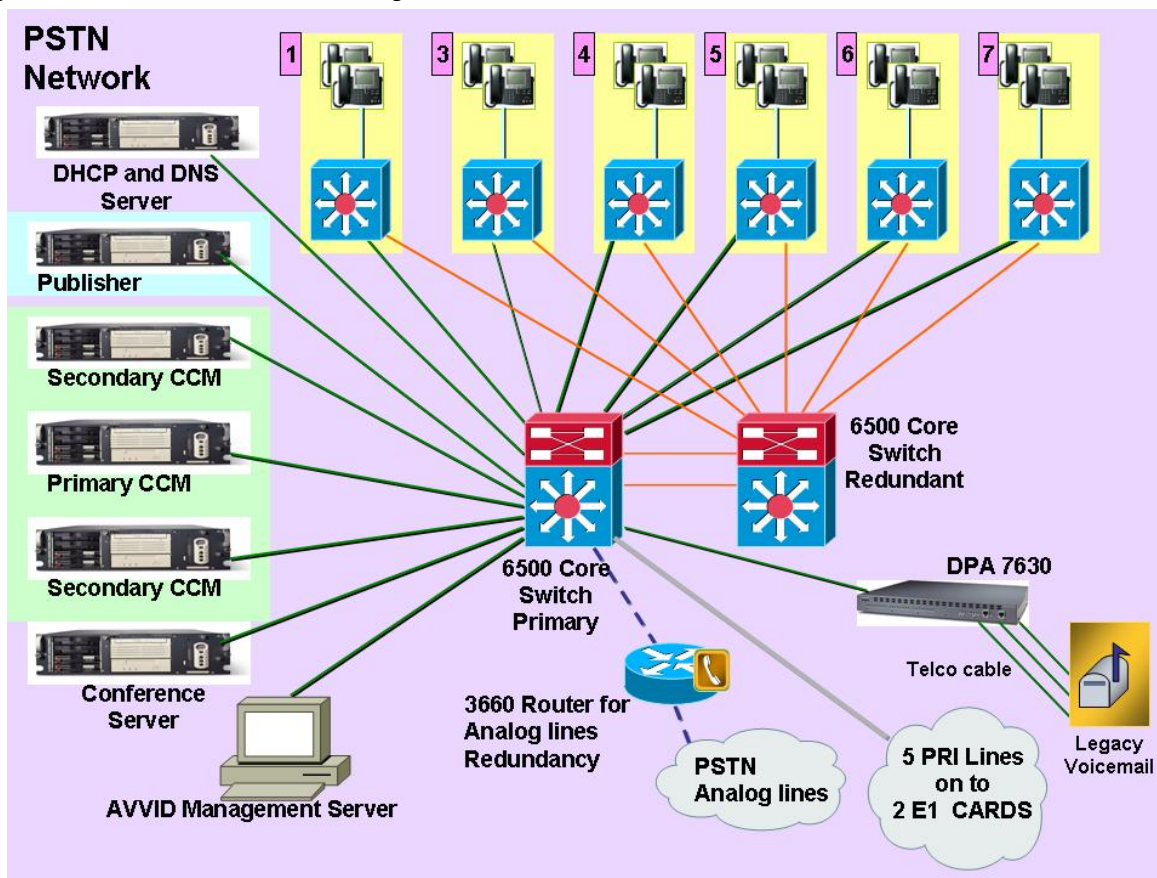
They would use their data network-connected IP phone to call San Jose, other Cisco sites in India, or partners in India such as Wipro and Infosys that were connected to the Cisco VoIP network (Figure 3). "There had to be an air gap between the two networks," says Balaji (Bala) V., manager, Cisco IT, APAC Network Operations.

Figure 3. Data (VoIP) Network Before Convergence
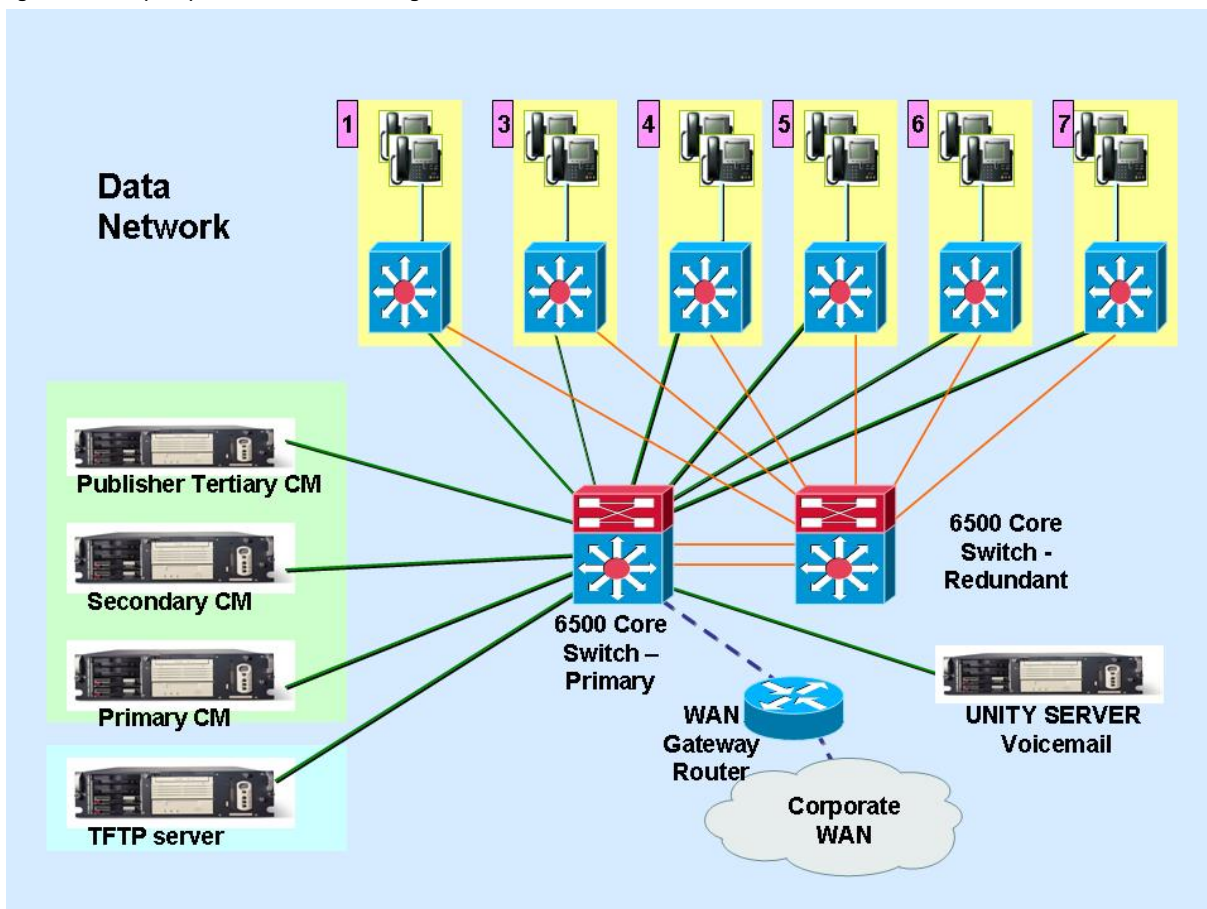
This dual infrastructure was costly to deploy and costly to manage because it required twice the equipment and twice the effort to maintain. Any company in India with a VoIP deployment faced these same issues. The challenge for Cisco IT was to find a way to merge the physical aspects of the two infrastructures without merging the calls—and to accomplish this in a manner acceptable to the local regulatory body.

Solution

Step 1: Unified voicemail

Achieving dual voicemail systems became the initial focus for integrating the two infrastructures. Messages left for employees on their VoIP line were stored in a Cisco Unity® voicemail system, while PSTN line messages were stored in another brand of voice messaging system. "We began to ask ourselves, why can't we have a single voicemail system so that whenever a Cisco employee accesses their voicemail, there is one mailbox to check," says Bala.

Bala and his team approached regulators, and explained that because voicemail is a store-and-forward technology, it does not require real-time flow of communications between the PSTN and the VoIP networks, which was prohibited. Approximately two months after beginning the approval process, Cisco IT was able to persuade regulators to allow convergence of the VoIP and PSTN voicemail infrastructure and received approval in November 2003.

Step 2: Unified clusters using Call Partitions and Calling Search Spaces

Cisco India began planning to combine the two voicemail systems into one, following the regulatory guidelines. Before the solution was implemented, Cisco India salespeople announced the approval to customers as they were showcasing the Cisco India IP telephony infrastructure during executive briefings. After viewing the solution, one customer immediately recognized the potential to take convergence one step further by collapsing the two Cisco CallManager clusters and sets of IP phones into one, while continuing to securely partition PSTN and VoIP calls. The single, converged Cisco CallManager cluster could route corporate calls over the data network, and all other calls over the PSTN network, by careful design of the dial plan. Cisco CallManager features of Partitions and Calling Search Spaces were configured to enforce strict dialing rules in the Route Plan.

Partitions and Calling Search Spaces are IP Telephony dial plan features that Cisco provides to support applications like Multi tenant configuration, geographic routing, or restricted calling. Cisco IT has used these features in the United States to make sure that phones in Cisco building lobbies cannot call outside the local area code. In Bangalore, the new CallManager cluster connects both to the WAN and to a set of PSTN gateways. Phone number ranges for calls that are allowed by government regulations to travel across the WAN (e.g. Cisco remote locations and some Cisco partner sites in India),are in one Calling Search Space for the WAN partition. The CallManager translates all phone numbers from that partition to the correct WAN IP address, and instructs the calling phone to connect to the called phone via IP across the WAN. All other phone numbers (e.g. a local India number, or a long distance call to a location not connected to the Cisco WAN) are all in a separate Calling Search Space for a second Partition, and all these calls are sent to the PSTN gateway, and routed over the India PTT network. As long as no revenue-generating calls were lost to the Indian telecom service providers, the government regulators would have no reason to prohibit the solution. "Our sales force alerted us to the customer's intentions of applying for this next level of approval and suggested that we should take a similar approach," says Bala. "This was indeed our next step."

Cisco IT submitted a detailed design document to regulators describing Cisco CallManager's ability to manage PSTN and VoIP as separate virtual networks, even though they resided on the same cluster. "I met with the regulators for almost three hours explaining our design and providing assurance that the voice will not flow from PSTN to VoIP and that we will keep them separate," says Bala. "I had to give them a feeling of comfort before they would approve this."

Approval was aided by a number of factors. Cisco IT had developed a long-standing relationship with regulators and had never experienced any violations or issues with respect to illegally routing calls. "Their comfort level and confidence in Cisco was very high," says Bala. Regulators were further convinced when Cisco agreed to allow authorities to audit the VoIP network whenever they chose. Approval for Cisco CallManager cluster convergence was received in June 2004.

Convergence implementation

Once approval was received for convergence of Cisco CallManagers serving the PSTN and VoIP networks, the focus shifted from converging voicemail systems to converging the Cisco CallManagers. "If Cisco CallManagers are converged, then voicemail convergence becomes almost automatic," says Bala.

In addition to Bala, contributing team members included Srinidhi Sampath Iyengar, design and testing; Sudhir Kamath, interdepartmental communication; and, Sanjeev Patil and Arun Joshi, management support.

When implementation of the converged Cisco CallManager solution began, the first location to migrate was Divyshree Chambers, the Cisco India campus in Bangalore. One Cisco CallManager cluster supported the PSTN infrastructure for the campus. However, on the VoIP side, the Cisco CallManager cluster supported not only Divyshree Chambers, but also remote locations, such as a number of sales sites, as well as Cisco partner sites including Wipro and Infosys. The preconvergence PSTN and VoIP infrastructure can be seen in Figures 2 and 3.

Migration consisted of removing the PSTN Cisco CallManager cluster in Divyshree Chambers and collapsing that infrastructure into the VoIP Cisco CallManager cluster at that same site. The surviving Cisco CallManagers were configured with virtual partitions to maintain the separation between PSTN and VoIP calls. Because of the complexity and number of locations impacted, the VoIP network was taken out of service over the weekend while the conversion was being implemented. On each Cisco employees' desk in Divyshree Chambers, one of the two existing phones was left in place and a second line was added to it. Cisco partners who connected to the VoIP network typically maintained their own PSTN infrastructure and continued to have two phones on each desk. This first phase of the project was completed in October 2004.

The second phase of the project involved collapsing the PSTN Cisco CallManager cluster at Cisco India's Waterford site in Bangalore into the VoIP cluster at Divyshree Chambers and replacing dual, single-line IP phones with a single two-line IP phone on each desk (Figure 4). This phase was completed in March 2005. Future phases will similarly involve removing local PSTN Cisco CallManager clusters and collapsing that infrastructure into the cluster at Divyshree Chambers.

Figure 4. PSTN/VoIP Network After Convergence
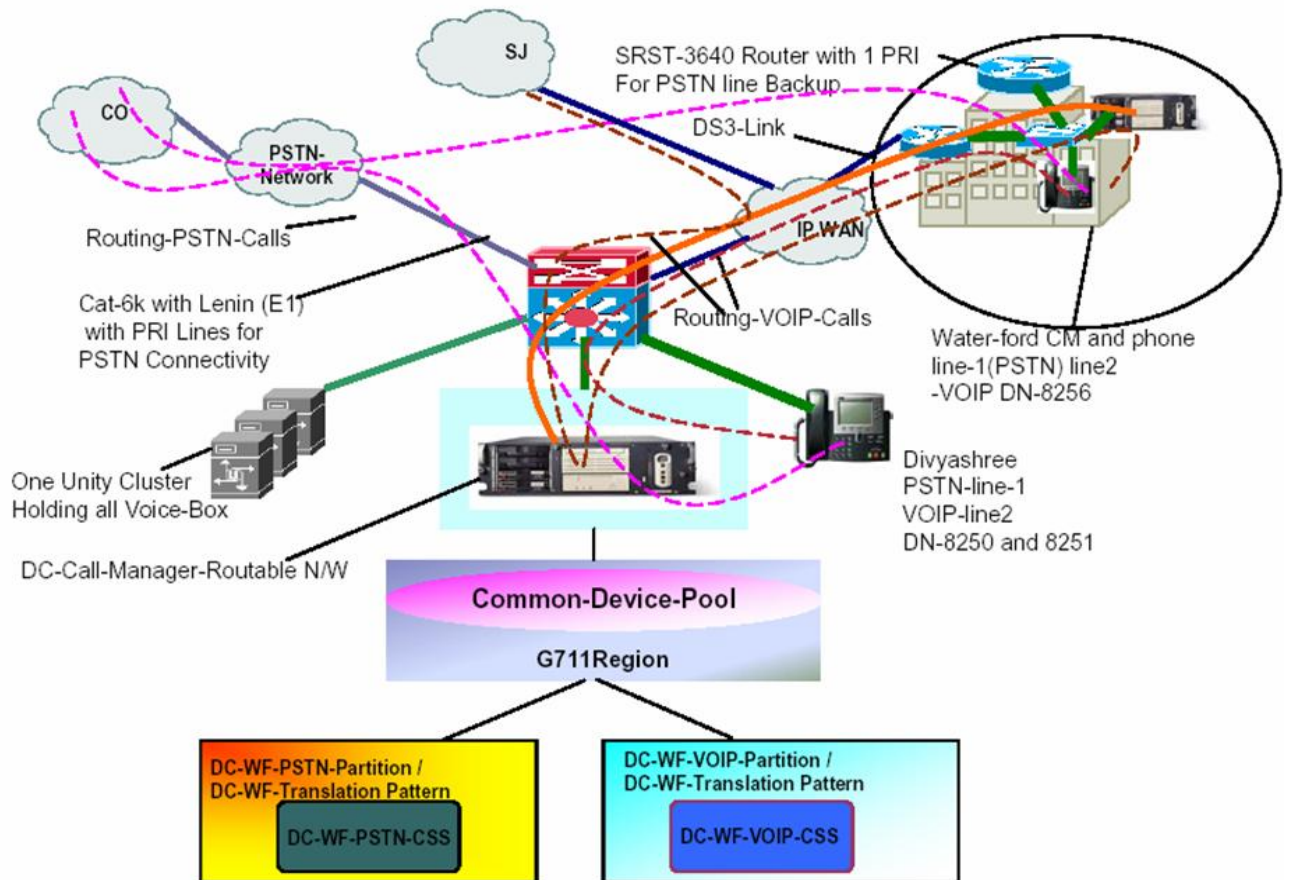
Results

Cisco employees on the Divyshree Chambers campus now use a single phone for both PSTN and VoIP connectivity. Approximately US$1 million of equipment has been reclaimed for local expansion, productivity has increased, and operational costs have been reduced. In addition, the converged environment provides a showcase that Cisco sales people can demonstrate to customers.

Lessons Learned

Cisco IT has gained valuable, first-hand experience in working with regulators in India and deploying and maintaining converged PSTN and VoIP network infrastructures. Some of the lessons learned in that effort include:

1) When approaching regulators to converge PSTN and VoIP network infrastructures, it is critical that the correct design documentation is presented, and that the plan for the partitioning is clearly stated. Regulators will likely create a list of tasks to be done. For example, they may ask for call logs for one year. The organization seeking approval should appear willing to comply with any and all requests.

2) The length of time to get approval is related to the level of pressure that is placed on regulators. Frequent follow up is essential for the approval process to progress. A sense of urgency must be created.

3) Collapsing PSTN Cisco CallManager clusters into VoIP clusters can be a complex task that impacts many users. Proper backup is needed to be able to halt the migration if a problem arises.

4) Some adjustments are normal and should be expected after deployment, such as modifications to routing tables.

Next Steps

As time and budget allow, the remaining PSTN Cisco CallManager clusters throughout Cisco India will be collapsed into a single Cisco CallManager cluster at Divishree Chambers that will support PSTN and VoIP for all Cisco India locations.

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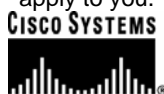
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