# Reality Based Telecom Switching©

## Bridging the Technology Gap in Telecommunications

*Real-world telecommunications networks present challenges to the network planner considering a move to VoIP. This paper explores the tradeoffs in this decision-making process.*

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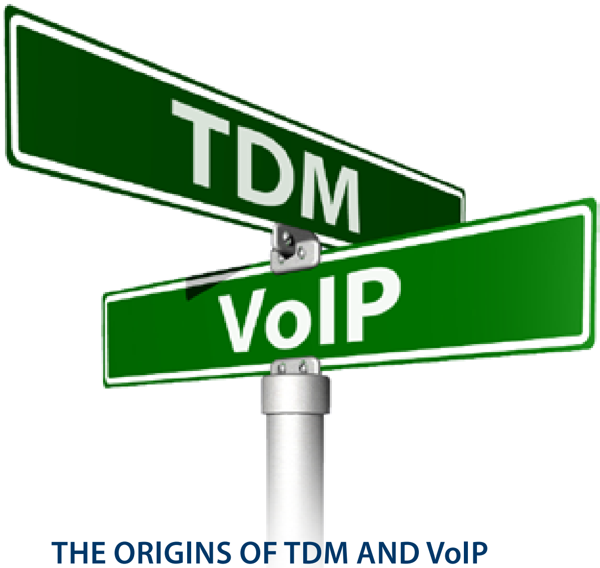


### THE ORIGINS OF TDM AND VoIP

Some of the differences between VoIP and TDM can be gleaned by noting their respective origins. For this discussion, TDM is used to refer to all telecom systems prior to VoIP—not just Time-Division-Multiplex.

TDM has its roots in the Public Switched Telephone System (PSTN), which in the US prior to the 1970s, was largely a monopoly of AT&T. As a direct result, a large body of detailed specifications and standards was developed. These standards evolved to become quite detailed and complex—but they changed relatively slowly over time. For example, a telephone designed in 1920 will still work on an analog line circuit designed in 2006. The same is true of most trunk interfaces. There was also continuity in the equipment manufacturers; with the exception of a few name changes, the same manufacturers dominated the industry for decades. This stability in standards and manufacturers was a significant benefit, and went a long way toward guaranteeing interoperability.

VoIP, having firm roots in the IP world, and especially with the emerging dominance of Session Initiation Protocol (SIP), moves on quite a different path. One of the first VoIP protocols, the H.323 standard, shares many similarities with Integrated Services Digital Network (ISDN), and thus with the TDM world of large, detailed and somewhat inflexible standards. By contrast, the roots of IP came from the Advanced Research Projects Agency (ARPA), which was founded in 1958. In the early 1960s this consortium of government and university researchers began to produce the first protocols for what would later be called "the Internet Protocol (IP)". Unlike the TDM world, IP is characterized by a large number of contributors, the general absence of complex, hard-to-understand specifications, and an ever-changing state-of-the-art. Even the name "Request For Comment" (RFC), the main mechanism for publication of IP standards by the Internet Engineering Task Force (IETF), reflects an "everything is subject to change without notice" philosophy.

Specifications coming from the TDM world generally assume hardware resources are limited and expensive; thus high development costs are affordable to make the best use of precious hardware by creating efficient and robust protocols. Besides, the PSC or PUC allowed these development costs to be passed on to the customer. At the time, this was a justifiable philosophy.

Specifications coming from the IP world are a counterpoint to the TDM philosophy. Hardware is assumed to be getting faster and less expensive all the time, while software development costs are skyrocketing. There is pressure to make the protocols easier for humans to read—this speeds development and testing—with little concern that the hardware uses more resources to parse the protocols. If a new protocol takes more memory or CPU cycles to process, it is justified by arguing "newer PCs will have the memory and speed to handle it; they will upgraded soon anyway." The IP standards also build heavily on existing concepts, reflecting the current thinking that layered protocols are better—better in terms of the time it takes to write the specs as well as to implement them. Minimizing the time it takes to write specs is important because many of the writers do this as a "side job" for private companies, rather than as a mainline task for a regulated utility. Often, their viewpoint values the reusability facilitated by a layered approach over the efficiency of the end product.

## THE REVOLVING DOOR OF IP TECHNOLOGY

An important trend can be seen in the migration of the overall control philosophies in telecommunications systems over the years.


> In traditional TDM systems the end instruments are "dumb"; they contained no call control logic. All call control logic resided in the PABX or Central Office switch.
>
> With ISDN, there began a shift to a shared control philosophy; the phones got smarter, but most responsibility for call control still resided in the central switch.
>
> With VoIP, this trend continued to the extreme. A simple VoIP network can be constructed without a central "PABX" or "Central Office" of any sort—the VoIP phones direct their activities themselves, cooperating with one another using an IP backbone that may not even be "aware" it is serving phones!

These differences in control philosophies are more than interesting intellectual observations. They actually manifest themselves in the resulting products.

> Specifically, a pure VoIP product is likely designed for a much shorter life cycle, using the PC model of dynamic obsolescence. There is pressure to periodically replace the computer infrastructure in any organization. Either the hardware cannot be repaired economically (forcing upgrades to the next level), or newer software versions won't run on the old hardware. In some cases, the new hardware requires software upgrades. Since most PCs and servers are running a number of applications simultaneously, there is an ongoing cycle of replacements and upgrades of hardware and software.



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VoIP is one of the applications stuck in this "technological revolving door". While this cycle may have positive implications for the economy as a whole, it is the cause of many sleepless nights for corporate bean counters. Ultimately, there will be on-going expenditures simply to maintain the status quo, even if the user's telecommunications requirements have not changed.

The TDM infrastructure has the inherent advantage of longer life cycles and lower continuing life-cycle costs. However, this is offset by the realities of the business world—an equipment manufacturer may decide not to support its "legacy" TDM equipment in the future, and may even terminate support for its existing customer base. Indeed, this has happened many times—it levels the playing field and makes it easier to justify replacing TDM equipment with VoIP technology. But once the switch to VoIP is made, for whatever reason, networks become stuck in the revolving door of software and hardware upgrades.

## HYPOTHETICAL CASE STUDIES: VoIP AND TDM

It is useful to examine extreme cases in order to clearly define the issues involved. Although exaggerated for illustration purposes, these case studies do represent real-life elements and considerations; they help us identify factors that go into the planner's "equation".

## VoIP: A VOICE NETWORK SOLUTION FOR NEXT GENERATION EMPLOYEES

***Company A*** is a start-up software design house in a fashionable high-tech area, employing a group of young hotshot software engineers. The top of the business priority list includes getting a good deal on workstations so that the team can get right to work. A LAN is also required to permit collaboration on projects and access to the common code base, and to facilitate centralized data backups. Internet connectivity is also needed to access specs, technical user groups and to obtain routine software and anti-virus upgrades for the workstations. ***Company A*** employs one or two MIS workers to support the developers' efforts.

Next on the priority list is some kind of phone system. In the early developmental stage of ***Company A's*** life, there is no need for a call-center supporting high call volumes—but the team does needs to be able to order pizza as they burn the midnight oil!

Here, the choice between VoIP and TDM favors VoIP:

VoIP is a new system, but there is no existing equipment to pose interoperability issues.

***Company A*** watches its cash flow closely, and a VoIP system leverages the already-justified IP infrastructure; the incremental cost of adding a phone system to the network is affordable.

Most of the cost of a VoIP system is in the station instruments. ***Company A*** has the option of forgoing the purchase of VoIP phones, and using workstation-based soft-phones instead. These are often "free" (employees already have a workstation), and the team accepts the soft-phone as a high-tech toy. These Next Generation users forgive VoIP shortcomings, compared to the traditional user who is likely to compare service quality with existing TDM systems.

There is little need for complex features in this environment. The simple "phone book" feature provided by many soft-phones eliminates the need for a Call Manager in ***Company A's*** simple network. The existing BOOTP and DHCP servers present within a corporate network are used to automatically load necessary databases into the VoIP terminals—in actual phones or workstation application programs.

Using broadband access to the Internet, access to the PSTN does not require a Media Gateway.

***Company A*** is limited to IP service providers for PSTN access, but this is viewed as a distinction without a difference.

Responsibilities for managing the "phone service" naturally falls to ***Company A's*** MIS group. Voice communications are handled by a technology team with many responsibilities, as opposed to a group of focused telecommunications experts.

## TDM: LEVERAGING AN EXISTING CORPORATE NETWORK

***Company B*** is an established organization heavily dependent on voice telecommunications. ***Company B*** has geographically diverse locations and desires either to expand its network or to reduce operating costs. ***Company B*** is typified by many large retailers or manufacturing companies. Traditionally, an organization such as ***Company B*** uses a PABX at each location with tie trunks between locations. (Centrex service from a local PSTN service provider is another option, but it is easier to compare technologies using the PABX option.)

The end users expect and require both high availability and high quality of service; they do not tolerate limitations or quirks in their system. ***Company B's*** workforce does not value any particular system architecture per-se.

***Company B*** relies on features such as call forwarding, voice mail and conferencing within their network. These features are the strengths of the mature TDM PABX and have resulted from years of experience and customer feedback. VoIP tends to be weaker in such features; VoIP paradigms even consider some of the features in TDM switches to be by-products of implementation—with VoIP, these features are either inherent in the networking central to IP, or are provided by the natural integration of IP-based multi-media applications existing on users' desktops.

Here, the planner is faced with a complex decision: A lot of expensive network reconfiguration can be done, and much new equipment purchased, all for a change without a significant benefit.

One approach to reduce operating costs is to use VoIP for the tie trunks between the various locations. Traditional TDM-based tie trunks such as T1s are expensive and involve recurring monthly charges. If a corporate data network already exists, it is tempting to use it for the VoIP traffic as well. If the existing broadband traffic is high enough, the effect of the additional VoIP traffic load can be estimated so that network capacity is optimized. This is preferable to dedicating fixed channels for the TDM traffic, while allocating the rest to data.

There are other options. Multiplexers exist which can dynamically allocate TDM channels as required for voice traffic, leaving the rest of the transmission capacity for data. This delivers many of the desired cost benefits while retaining the TDM network architecture.

However, if an existing corporate IP network is to be used for VoIP traffic, it must become a "managed network" (if it isn't already), and a Quality-of-Service (QoS) technique such as Diffserv (Differentiated Services) or MPLS (Multi Protocol Label Switching) must be employed within the network to guarantee voice quality.

The cost-conscious network planner is tempted to pass the VoIP traffic onto the public Internet to significantly reduce monthly charges—but the maneuver is fraught with serious risks. One of the most serious risks is the lack of packet prioritization in the public Internet. Even though the endpoints in the corporate network may include QoS information (such as Diffserv offers) in the VoIP packets, this is not supported in the public Internet and quality is unpredictable at best. Just as serious is the security risk. Security risks are mitigated if the existing corporate network is used, because physical security and encryption protect the corporate data stream. But when the public Internet is used, additional major threats include eavesdropping, denial-of-service, and spoofing. The fact that the external network is "untrustworthy"—from a security perspective—makes security requirements very difficult to meet. The Internet is not an appropriate place to conduct private network communication!

## THE BEST OF BOTH TECHNOLOGIES: BRIDGING TDM AND VoIP

The preceding examples were idealized to point out some of the factors that the network planner must consider. Real world scenarios are more complex. If a network is large, geographically or functionally distributed, or if it interoperates with a number of established legacy systems, a hard or "flash" cutover from TDM to VoIP is not warranted, or even desirable. The best solutions permit the end user to enjoy a high QoS, while maintaining existing features and applications. A solution that bridges TDM and VoIP technologies allows the network planner to take advantage of the economies and flexibility made possible by the prudent application of VoIP to the network.

A network may have a many locations or nodes where concentrations of end users exist. These nodes are likely to include a TDM switch and have interfaces to other analog or digital TDM-based equipment, including trunk access to a local PSTN, interfaces to specialized voice mail or announcements, or company-proprietary equipment. It is not desirable, economically feasible, or even possible to completely replace the existing infrastructure with a VoIP solution overnight. The ability to mix and match between TDM and VoIP with as much feature transparency as possible allows the economies of VoIP to be introduced at the points in the network where it makes sense. Where TDM-based or proprietary interfaces exist, a Media Gateway can provide the bridge to the VoIP world, and a Call Manager can mediate between VoIP and TDM applications to achieve significant feature transparency. These two functions need not be separate pieces of equipment.

Trunking between locations is converted to VoIP as a first step, preserving investment in existing switches and telephones at the various locations. This produces significant cost savings with minimal investment. Then, a VoIP infrastructure permitting smaller sites to be created based totally on VoIP will be in place. Creating new "VoIP islands"—bridged to the mainland—is easier to justify because there is no replacement of analog or IDSN telephones. If they employ SIP, these VoIP telephones or workstations would home on a SIP Registrar in one of the network nodes using a Call Manager. If there are only telephone-type devices at that location, nothing more is required than the normal IP LAN that exists anyway. All Media Gateway and Call Control functions are handled at a node where these functions are provided. Calls originating within the network as VoIP stay as IP calls; they are only converted to TDM using Media Gateway resources when and if required. Likewise, a call coming in from the TDM side continues to use TDM if available; its voice stream is only converted to VoIP if the endpoint is a VoIP telephone or if a VoIP trunk is required between nodes. This avoids double conversions that add cost and reduce voice quality.

When nodes are interconnected with VoIP, the concept of "trunk" can take on a somewhat different meaning. Normally a trunk in the TDM world connects two specific switching nodes and each trunk handles a call between subscribers located in those respective nodes, or between subscribers who have reached those nodes through routing. The IP network inherently provides a switching function so that a number of nodes could provide a single physical group of "IP trunks" to a WAN (Wide Area Network), and if the WAN permits them to see each other, each node can direct traffic as required to any other node. However, the network planner may arrange a Call Manager to enforce per-route call limits as part of a QoS program. IP allows this kind of global resource sharing which is not easily provided in TDM networks.

## CONCLUSION: HYBRID SWITCHING BORN OUT OF REAL WORLD NEEDS

Real-world networks will be a hybrid of multiple technologies for some time to come. With Call Managers and Media Gateways distributed throughout the network at points where concentrations of end users or legacy interfaces exist, VoIP and TDM can be used to their respective best advantages to minimize overall cost, better amortize existing investment, and mitigate the risks associated with migration to a new technology and era.

### REDCOM COMPANY PROFILE

Located near Rochester NY, REDCOM designs and manufactures state-of-the-art telecom switching systems. Since 1978 REDCOM has provided high quality, reliable telecom switching equipment for public and private markets worldwide. REDCOM's patented digital switching systems are used in private networks (international gateways, private exchanges, and power line carriers), public networks (central offices), wireless, call management, emergency/rapid response systems, programmable switching platforms, government systems, and ISDN systems.

REDCOM's experience in legacy systems, coupled with its knowledge of IP networks, equips it to provide solutions that deliver on the promises of a VoIP future—without stranding investment in legacy systems during the migration to an IP future. REDCOM does this while maintaining its legendary reliability and maintainability, even in the world's most demanding environments.

REDCOM's focus on the customer, its experience, and its willingness to adapt have made it a leader in an industry of larger, less flexible competitors. In today's demanding and rapidly changing telecom environment, ***REDCOM delivers Reality Based Telecom Switching.***



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