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Introduction

If there's one safe bet in communications, it's that Voice over IP (VoIP) usage will continue to grow. That's because for service providers and customers alike, VoIP significantly reduces the cost of voice calls while also enabling new features and call quality that's superior to traditional circuit-switched telephony. Infonetics Research estimates that nearly half of small and two-thirds of large enterprises in North America will be using VoIP products and services by 2010. That's double the adoption of 2006.

On the consumer side, VoIP adoption grew 125 percent in 2007 among U.S. households, according to Yankee Group. By 2011, 37 million U.S. households will use VoIP, the firm estimates. That's more than four times the amount in 2006.

That strong, sustained growth continues to appeal to VoIP hardware vendors, increasing competitive pressures. To stand out from the crowded pack, makers of IP phones and VoIP gateways increasingly are turning to digital signal processors (DSPs) to develop products with market-differentiating features, including high performance, superior quality of service (QoS), reliability, power efficiency and field upgradeability.

Harnessing the power of DSPs for VoIP

DSPs have played a major role in the success of VoIP. Here's why – and what they'll do next.

Why DSPs?

The VoIP phenomenon is a byproduct of advances in processors. But not all processors are created alike, and their differences directly affect their ability to support VoIP in a way that meets the requirements of service providers and end users.

Reduced Instruction Set Computer (RISC) processors are an option that some vendors evaluate because they continue to get faster and advertise some real-time capabilities. Unfortunately, they still lack the performance and features necessary to do real-time signal processing and multi-channel applications without showing the strain.

RISC processors also are rigid in the sense that they can't be easily upgraded in the field to support new algorithms and codecs. That's a major disadvantage, considering how rapidly VoIP is evolving and that devices such as VoIP gateways typically remain in service for about five years – and sometimes longer.

Those drawbacks are among the reasons why vendors continue to use DSPs for VoIP applications. From the earliest days of IP telephony, DSPs have played an essential role ensuring high-quality voice service. As VoIP end-equipment evolves to include additional multimedia applications such as video communications, audio streaming and video transcoding, DSPs play an even more important role. Not only are other processors inefficient when it comes to voice and video compression and real-time processing, but programmable DSPs also allow for feature and standard evolution in an unparalleled way.

The real-time processing capabilities of DSPs are ideal for voice processing tasks such as:

- Voice-activity detection
- Canceling the signaling echo on the line that's produced by reflections caused by hybrid four-wire-to-two-wire transitions and other anomalies
- Pulse code modulation (PCM) processing
- Data stream compression to conserve bandwidth
- Tone generation and detection
- Jitter buffering
- Comfort-noise generation
- Acoustic echo cancellation in speaker phone applications, a task that includes supporting codecs such as G.167 AEC

By comparison, general-purpose processors such as RISC devices are better suited for non-real-time data processing and control tasks, such as the system's human or machine interface, or its database processing. A DSP with its high-speed, real-time multiply-and-accumulate (MAC) capabilities, however, can rapidly process the mathematically intense tasks that make it a natural fit for the requirements of high-quality voice processing and security in IP phones.

The multicore advantage

Multicore DSPs also provide a mix of performance and efficiency that's superior to single-core devices for multi-port applications (see figure 1). As application demands increase, simply increasing megahertz no longer is a viable solution because of the power required and the heat produced.

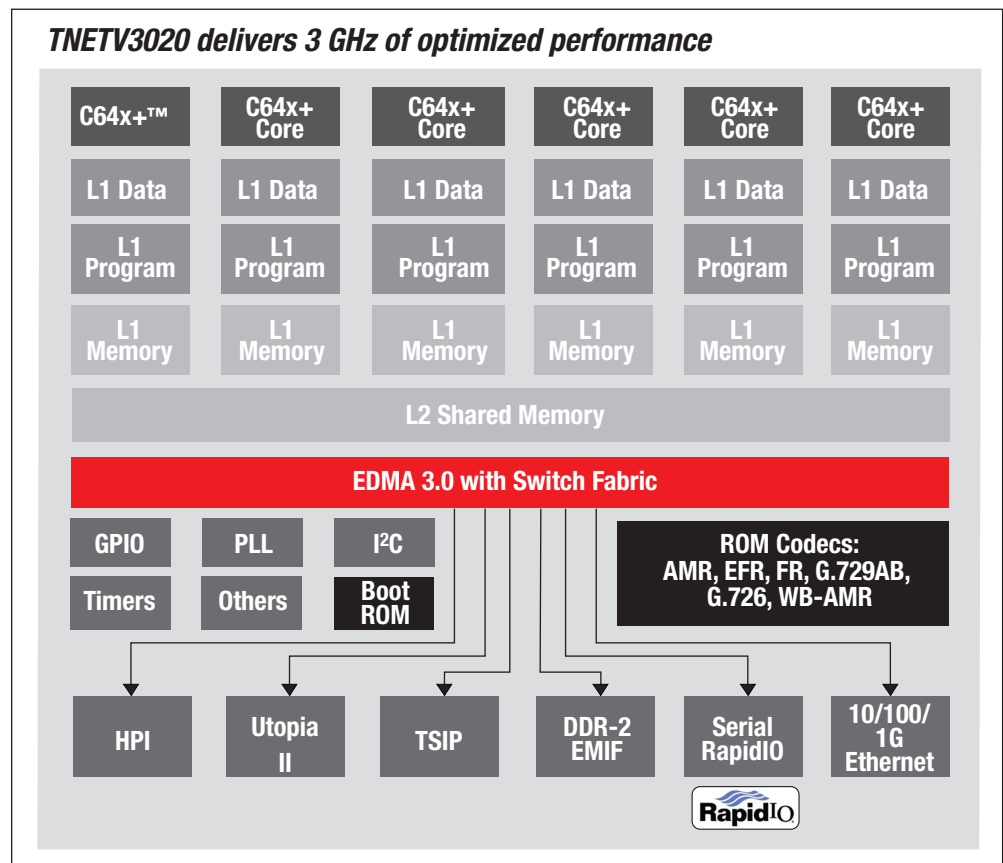


Figure 1

For example, if the system requires 3 GHz worth of performance from a DSP, the device can be designed with three cores running at 1 GHz each, all in a single DSP package. This design reduces power consumption, which can be a market differentiator as consumers and enterprises increasingly seek out energy-efficient communications products. Low power consumption is a must for VoIP equipment that uses battery backup to maintain 911 service during power outages. In fact, the ability to make emergency calls hours into a power outage can help cable operators convince telco customers to switch to cable VoIP.

Multicore DSPs also are an ideal fit for dual-mode (cellular and Wi-Fi) phones, which are part of the worldwide, industry-wide trend toward fixed-mobile convergence. Multicore DSPs' low power consumption enables VoIP over Wi-Fi services that don't quickly drain the battery. Battery life - or lack thereof - is something that reviewers always note, so multicore DSPs enable systems designers to create VoIP products whose power efficiency is a market differentiator.

In some cases, battery life can directly affect a service provider's business plan and bottom line. For example, if a service provider's dual-mode handsets last for hours in VoIP mode, then customers will be more likely to use VoIP mode when a Wi-Fi signal is available, instead of reverting to cellular – a major plus if the service provider is a wireless carrier that wants to offload as many voice calls as possible to Wi-Fi in order to avoid the expense of adding cellular infrastructure.

Finally, because their multicore design enables them to run at lower speeds with no trade-offs in real-time performance, these DSPs also run cooler, a major plus in a device that users must hold for extended periods. Less heat also means less stress on all of the device's components, potentially extending the phone's or gateway's lifecycle and improving its reliability. That in turn reduces customer-support costs for the hardware vendor and/or the service provider, as well as avoiding the chance of chronic hardware failures that would sully their brands.

V is for video

Although VoIP is synonymous with voice calls, VoIP end-user equipment increasingly must handle video applications, too. In the enterprise market, many companies are deploying videoconferencing or telepresence equipment in order to reduce travel costs and time, particularly for executives. Steadily declining hardware costs are also spurring video communication adoption, as are systems designed for use in individual offices and cubicles instead of only conference rooms.

That adoption increases the market for telepresence and IP videoconferencing endpoints that support VoIP. There's also growing demand on the consumer side, where devices ranging from cell phones to PCs to TVs increasingly must handle video and VoIP side by side. That creates a need to transcode that data into the various formats that each end-user device can accommodate.

In both those devices and the networks that they're connected to, DSPs play a key role in transcoding those ever changing and growing number of formats. Transcoding directly affects the market for VoIP and video devices and services by ensuring that they're accessible to as many consumers and enterprise users as possible, instead of only those with the right hardware.

DSPs enable the compression that allows high-quality voice and video to travel efficiently over existing data networks. This is a challenging task because it has to be done in real time. After all, latency in voice and video is noticeable to end users. If it's bad enough, latency directly affects the service provider's bottom line by increasing customer-care costs, churn or both. Hence the importance of using DSPs, which are well-suited for processing-intensive, real-time tasks.

The inherent structure and complexity of codec algorithms drive the requirement for a DSP or specially designed hardware. Encoders are particularly important because they must adapt to the application and

because they represent a major portion of the heavy processing load of video applications. Although encoders are based on the mathematical principles of information theory, they may still require implementation tradeoffs which can be quite complex.

The DSP is much better suited than specially designed hardware specific to one video or audio codec standard because of its ability to adapt to changes in this rapidly evolving market. As video is incorporated into more communications applications, there will continue to be optimizations to the standard, as well as proprietary ways to best compress the data and deliver the highest quality over the lowest bandwidth.

Going green

Although performance, reliability and QoS are among the main reasons why systems designers are increasingly choosing both single-core and multicore DSPs – for VoIP hardware, another motivation is that they want to meet the growing service provider and end-user demand for “green” products.

Just as using DSPs extend battery life in wireless IP phones; it also reduces power consumption for wired VoIP devices such as gateways and desk phones. VoIP handsets typically are ranked and differentiated by the amount of power they consume and/or their power source. For example, many models draw power over the network by using Power-over-Ethernet (PoE) technology. Deploying many power-hungry IP phones would drive up the utility bills of enterprises that use those models – a potential drawback in the eyes of IT managers when they’re calculating the total cost of ownership (TCO) for a VoIP system. If power consumption significantly increases the TCO, some enterprises might not be able to make a business case for deploying VoIP.

Similar benefits apply on the network side. For example, the multicore design also runs cooler, so the VoIP infrastructure requires fewer fans in each rack and less air conditioning for the facility. Fewer fans also reduce both BOM costs and the number of mechanical components that could fail. Finally, less heat means less stress on components, reducing the chances of VoIP service outages.

By comparison, RISC processors require two to three times the megahertz to deliver the same level of performance. That horsepower translates into much higher power usage and heat emissions.

One highly effective way to reduce power consumption in a VoIP device is to reduce the number of processor cycles needed to perform each function. Put simply, each processor cycle consumes power, so expending fewer processor cycles leads to far less power consumption. This approach is particularly valuable for voice-processing tasks, such as codec processing.

Another simple power-saving technique involves the on-chip memory integrated with the DSP core. A relatively large amount of low-power memory on-chip reduces the number of off-chip memory accesses the processor must make. Because off-chip memory accesses consume significantly more power than on-chip accesses, the size and power consumption characteristics of on-chip memory will affect the system’s overall power consumption.

Several of the more sophisticated DSP cores have built-in power management features that reduce both operating and standby power consumption in IP phones. For example, TI's TNETV2502 can partition on-chip and off-chip resources such as I/O interfaces, peripherals and memory (see figure 2). That design means that the power can be turned off for a specific resource or a segment of the system when it is not in use.

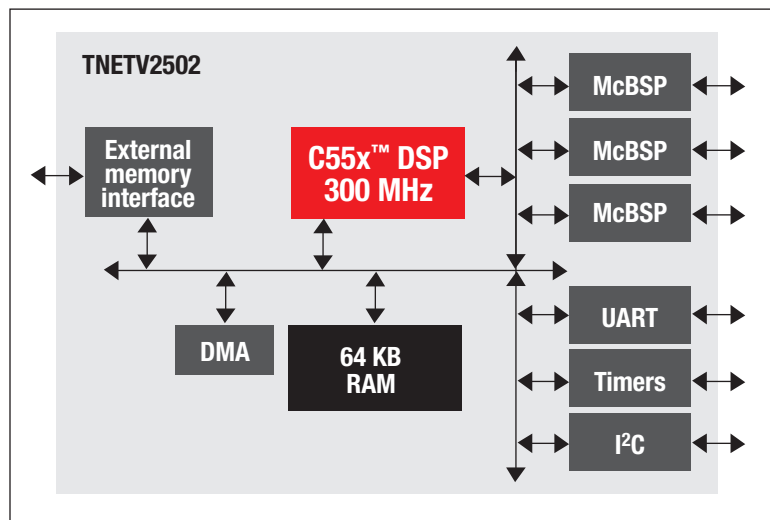


Figure 2

Another power-reduction feature involves dynamically scaling the voltage and frequency of a DSP core. For example, most IP phones are idle for extended periods of time. A DSP is capable of monitoring the state of the system and can reduce its own clock rate if the processing load dips below certain thresholds, thus minimizing power consumption. And when the voltage is reduced along with frequency, the incremental power savings is proportional to that decrease.

Getting the job done

Successful products are the sum of their parts. In the case of VoIP devices and infrastructure equipment, those parts often are DSPs, which provide the real-time performance necessary to provide high-quality voice services.

As programmable devices, DSPs also provide a certain level of future-proofing, such as the ability to upgrade to new algorithms and codecs in the field – a major benefit for equipment vendors, service providers and end users. That flexibility also enables bug fixes in the field, thus reducing customer support costs and giving service providers and hardware vendors a way to address problems even before they become noticeable to customers.

DSPs already have played an essential role in the deployment and increasing popularity of VoIP. Indeed, without DSPs, VoIP would not be where it is today. As the market continues its progression with next-generation capabilities such as wideband audio and high definition video, DSP technology, with its unique combination of real-time processing, scalability and low power consumption, will play an even greater role in the success of IP communications services.

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