VoIP
gateway solutions

TEXAS INSTRUMENTS

Product bulletin

Texas Instruments (TI) offers a broad family of scalable voice over IP solutions (VoIP) based on TMS320C55x™ and TMS320C64x+™ DSP cores and Telogy Software™ products. These single-device silicon and software solutions offer many levels of channel densities, from 4 to 128 G.711 channels or from 4 to 64 channels of compressed voice with SRTP. With this wide variety of offerings, TI has a VoIP solution for every level of product, from small business and enterprise VoIP gateways to service provider access gateway applications. Advanced DSP processing enables superior voice quality, functionality and scalability to deliver cutting-edge products with lower system costs.

TI's full range of VoIP solutions offers optimized solution density and faster time to market for manufacturers. With the largest installed base, TI's VoIP offerings reduce risk and offer a field-proven technology. With evaluation modules (EVMs) available for all solutions, developers are able to begin prototyping and developing new products now, saving time and money on new product development.

VoIP gateway solutions are available in two platform architectures to meet the needs of all gateway platforms. TI offers several highly integrated solutions based on the C55x™ DSP:

- System-on-chip (SoC) solutions integrating the DSP and RISC cores:
  - TNETV1060
  - TNETV1061
- DSP-only solutions:
  - TNETV2510 – single-core DSP
 - TNETV2520 – dual-core DSP

These solutions increase system integration and performance at reduced power levels and board space for low- to medium-channel density applications.

TI also offers several C64x+™ DSP-based solutions – all based on single-core DSP architectures:

- TNETV2664
- TNETV2666
- TNETV2686
- TNETV2689

Key features

- Advanced DSP processing enables superior voice quality, functionality and scalability
- Highly integrated processors enable lower system costs
- Field-proven software with emphasis on managing voice and call quality
- Most comprehensive range of features
- Largest installed base of solutions with more than 700 million ports shipped
- Industry leader in DSP
  - Committed roadmap support
  - Code compatibility
  - Process technology
  - Production facilities
- World-class technical support
- Industry leader in indemnification with broad patent portfolio
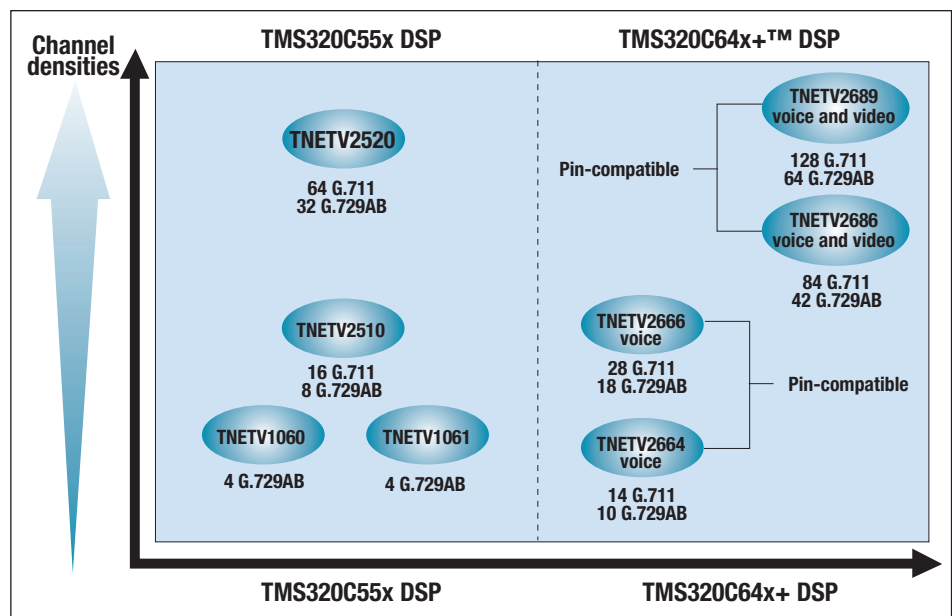
▲ *Voice gateway solutions diagram*

These highly integrated devices push the envelope on system performance based on TI's C64x+ DSP technology. The C64x+ DSP core offers several benefits over previous DSP cores, including:

- 20 percent higher cycle performance
- 16-bit compact instructions and SPLOOP buffer to deliver 20-30 percent smaller code size and reduced system cost
- Real-time bandwidth management and memory protection deliver enhanced development
- Better debugging through exception handling and cache coherency visibility

With many different solutions to choose from, TI VoIP gateway solutions give manufacturers the flexibility needed to design the right product for their market.
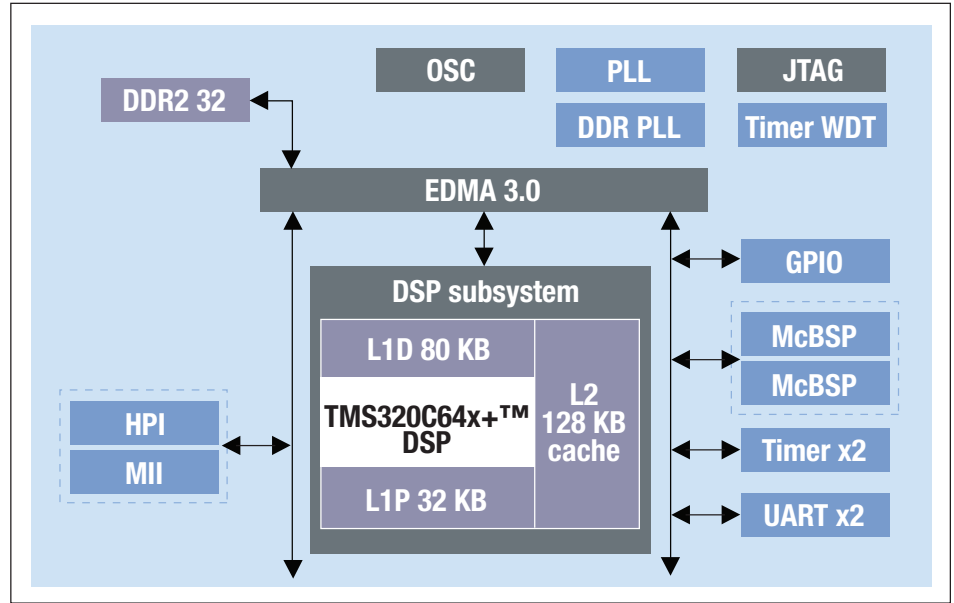
TNETV266x
VoIP gateway solution

TI's TNETV266x VoIP gateway solution integrates Telogy Software products with TI's industry-leading C64x+ DSP to provide a low-cost, scalable, voice-only solution that can provide from 8 to 28 or more G.711 channels with a 128-ms echo canceller tail. Using the Media Independent Interface (MII) and an external Ethernet switch, the TNETV266x can be scaled to provide device population options to meet multiple product configurations.

In addition to the high-performance C64x+ DSP, the TNETV266x devices offer DDR2 external memory interface for faster memory accesses. It also offers all the needed system interfaces for simpler designs. With two pin-compatible TNETV266x devices, TI offers a solution at the density needed for your gateway product. Supported codecs include G.711, G.726, G.729AB, G.723.1A, G.722 and Internet Low Bit Rate Codec (iLBC).

TNETV266x key features:
- C64x+ DSP core operating at:
  - 400 MHz for the TNETV2664
  - 600 MHz for the TNETV2666
- Channel densities:
  - TNETV2664 – 14 G.711 or 10-LBR channels
  - TNETV2666 – 28 G.711 or 18-LBR channels
  - 128-ms echo canceller
  - T.38 fax relay
- 32-bit DDR2 with 333-MHz clock
- Internal memories:

TNETV266x

▲ TNETV266x block diagram

- 80-KB L1D cache
- 32-KB L1P cache
- 128-KB L2 cache
- System interfaces: HPI / MII, two McBSP, two UART, GPIO
- EVM available
- Packaging: 16 x 16-mm BGA, 0.8-mm pitch, lead-free

TNETV268x
VoIP gateway solution

While the TNETV266x is for voice-only, the TNETV268x addresses voice and video capablities. A key benefit of the TNETV268x is the low-cost scalability available through daisy chaining using the integrated Serial Gigabit Media Independent Interface (SGMII)

TNETV268x
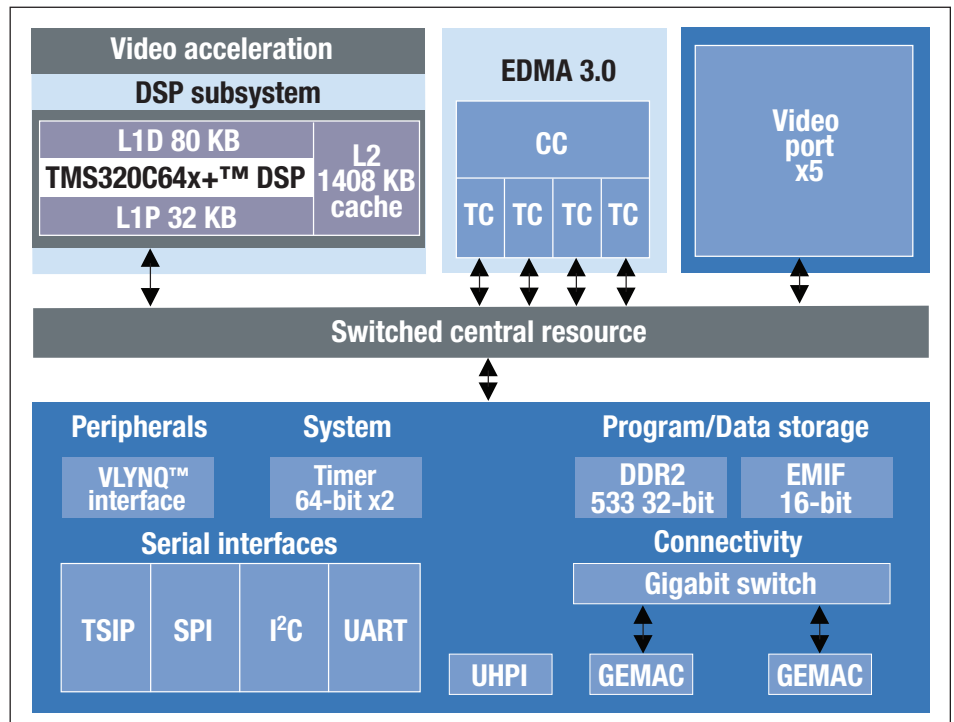
▲ TNETV268x block diagram

and internal gigabit switch. With two different pin-compatible devices available, offering from 84 to 128 G.711 channels with a 128-ms echo canceller, TI is able to meet the needs of different channel densities and applications. Supported codecs include G.711, G.726, G.729AB, G.723.1A, G.722 and iLBC.

The TNETV268x solutions have built-in peripherals and video acceleration to enable video encode/decode/transcode operation. This feature will allow manufacturers to use the same hardware architecture to provide a voice-only, a video-only, or a voice and video product.

TNETV268x key features:
- C64x+ DSP core with built-in video coprocessor
  - TNETV2686 operates at 515 MHz
  - TNETV2689 operates at 900 MHz
- Channel densities
  - TNETV2686 – 84 G.711 or 42-LBR channels
  - TNETV2689 – 128 G.711 or 64-LBR channels
  - 128-ms echo canceller
  - T.38 fax relay
- 32-bit DDR2 with 533-MHz clock
- Internal memories:
  - L1D/P: 32 KB each
  - L2: 1408 KB
  - ROM: 768 KB
- System interfaces:
  - Four-wire CML SGMII
  - 16-bit UHPI
  - Five dual-channel video ports
  - TSIP (TDM: 2x 16-MHz clock)
  - VLYNQ™ communications interface products
  - GPIO
- Internal peripheral: 3-port gigabit L2 switch
- EVM available
- Packaging: 19 x 19 mm, 0.8-mm pitch, lead-free

TNETV2510
VoIP gateway solution

TI's TNETV2510 VoIP gateway solution integrates Telogy Software products with a DSP-only architecture to provide a flexible solution for small business and enterprise gateway applications. With complex features

TNETV2510
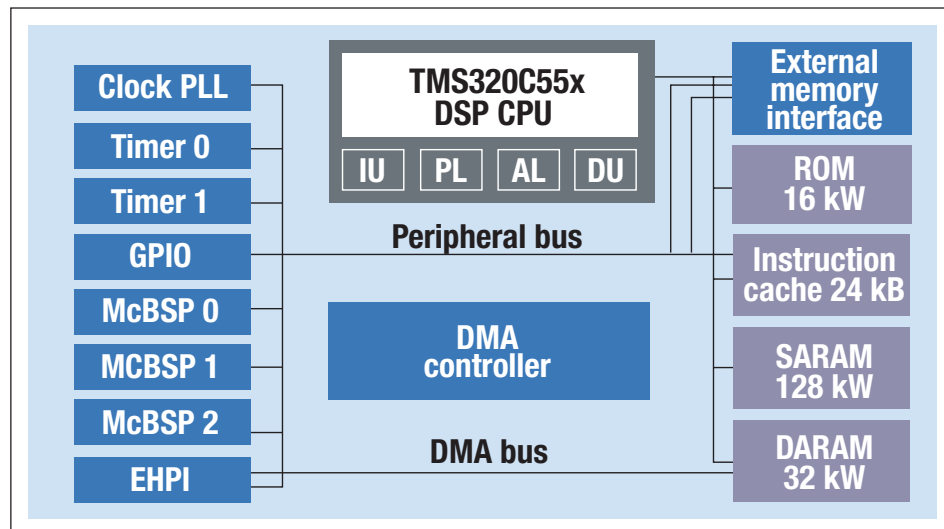
▲ *TNETV2510 block diagram*

suite support and increased channel density, the TNETV2510 is ideal for voice add-on modules. This VoIP gateway solution supports up to eight channels of LBR vocoders along with a 128-ms echo canceller tail. Supported codecs include G.711, G.726, G.729AB and G.723.1A.

TNETV2510 key features:
- C55x DSP core operating at 200 MHz
- Channel densities:
  - Eight channels LBR vocoder or T.38 fax relay
  - 16 channels G.711
  - 128-ms echo canceller
- Internal memories:
  - DMA controller
  - 160 K x 16-bit on-chip RAM
  - 6 K x 16-bit on-chip program/data ROM
- System interfaces
  - EMIF
  - EHPI
  - Three McBSP
  - GPIO
  - Two timers
- EVM available
- Packaging: 240 ball, 15 mm x 15 mm MicroStar BGA™ integrated circuit packages

TNETV2520
VoIP gateway solution

TI's TNETV2520 VoIP gateway solution, based on TI's C55x DSP and Telogy Software products, delivers high-performance voice

processing for T1/E1 enterprise applications. The TNETV2520 can be implemented in stand-alone VoIP gateways, as a VoIP gateway card in legacy PBX or IP-PBX applications, or as a service provider access gateway.

TNETV2520 combines a dual-core 300-MHz C55x DSP-based device with Telogy Software products to create VoIP gateway platforms targeted at medium-density gateways for both enterprise and service provider applications. The solution provides voice processing and conference bridging capabilities supporting 64 channels of G.711, 32 channels of G.729AB and 24 channels of G.723.1A. Also included in the TNETV2520 solution are the needed memory and system interfaces, as well as a GbitMAC with GMII port to allow IP encapsulation on the DSP, lowering the host processor load.

TNETV2520 key features:
- Dual C55x DSP core operating at 300 MHz each
- Channel densities:
  - 32 channels LBR vocoder or T.38 fax relay
  - 64 channels G.711
  - 128-ms echo canceller
- Internal memories:
  - 24-kB I-cache/subsystem
  - 192-kW/core local data memory
  - 25-kW shared ROM
  - 256-kW shared program RAM
- System interfaces
  - Global DMA

- ○ Communications subsystem
- ○ Shared peripheral interfaces
- ○ EMIF (16 bit @ 150 MHz), supports DDR
- ○ 32-bit HPI (Muxed mode)
- ○ Four Enhanced McBSP
- ○ 10/100/1G GMII (MII) Ethernet
- ○ Two 6-pin VLYNQ communication interfaces
- ○ 16-/8-bit UTOPIA-2
- • EVM available
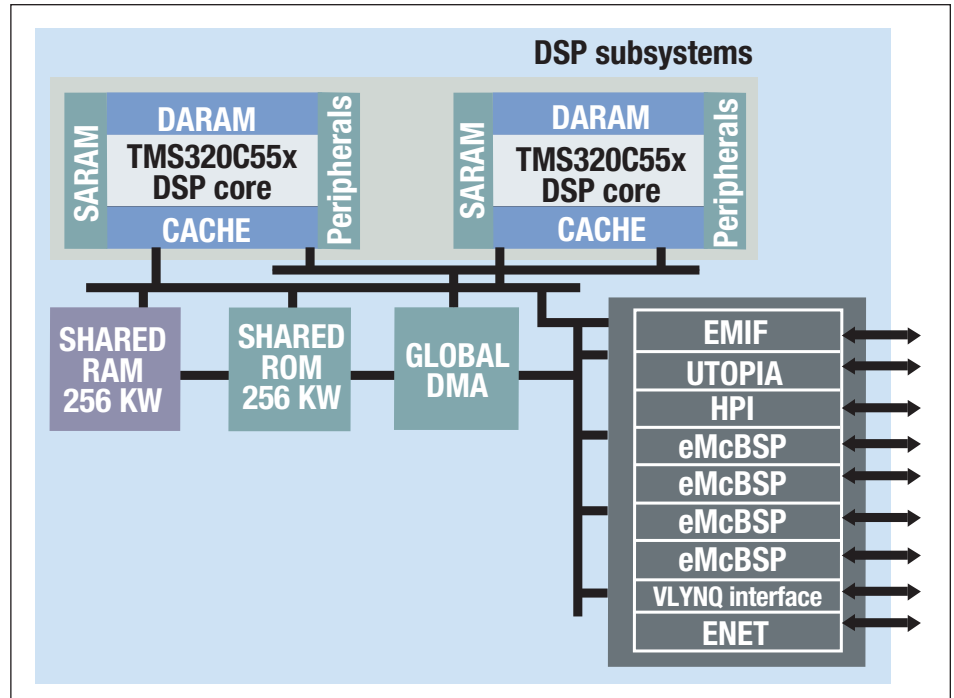- • Packaging: 16 mm x 16 mm

TNETV1060
VoIP gateway solution

TI's TNETV1060 VoIP gateway solution integrates Telogy Software products with TI's C55x DSP-based access communications processor to provide a cost-effective, highly integrated SoC for small business equipment gateways.

TI's integrated access communications processor includes a C55x DSP core and a MIPS RISC processor, memory and common system functions, system interfaces, and two Ethernet MACs/PHYs. The TNETV1060 can support up to four channels of LBR vocoders or T.38 fax relay, along with a 64-ms echo canceller tail. Supported codecs include G.711, G.726, G.723.1A, G.729AB, GSM-AMR, GSM-EMR and EVRC.

TNETV1060 key features:
- • SoC integrating:
  - ○ C55x DSP core operating at 125 MHz
  - ○ MIPS R4000 core operating at 165 MHz
- • Channel densities:
  - ○ 4 LBR or T.38 fax relay channels
  - ○ 32-ms echo canceller
- • Memory:
  - ○ DSP: 64 K-word RAM on chip
  - ○ MIPS: 16-KB I-cache and 16-KB D-cache
- • System interfaces:
  - ○ Two 10/100 Ethernet MAC/PHY
  - ○ EMIF
  - ○ Five-pin VLYNQ communications interface
  - ○ UART
  - ○ Two McBSPs
  - ○ GPIO
- • Packaging: 324-terminal plastic ball grid array (PBGA)

TNETV2520

▲ TNETV2520 block diagram

TNETV1061
VoIP gateway solution

TI's TNETV1061 VoIP gateway solution provides a complete, cost-effective VoIP solution targeted for small business applications. Integrating both the DSP-based communications processor with Telogy Software products, the TNETV1061 is also available in industrial temperature ranges (from -40 to 105 °C).

TI's integrated access communications processor includes a C55x DSP core and a MIPS32 4KEc 32-bit RISC processor, memory and common system functions, system interfaces, and two Ethernet MACs/PHYs with integrated support for AutoMDIX. The TNETV1061 can support up to four channels of LBR vocoders or T.38 fax relay along with a 64-ms echo canceller tail. Supported codecs include G.711, G.726, G.723.1A, G.729AB, GSM-AMR, GSM-EMR and EVRC.
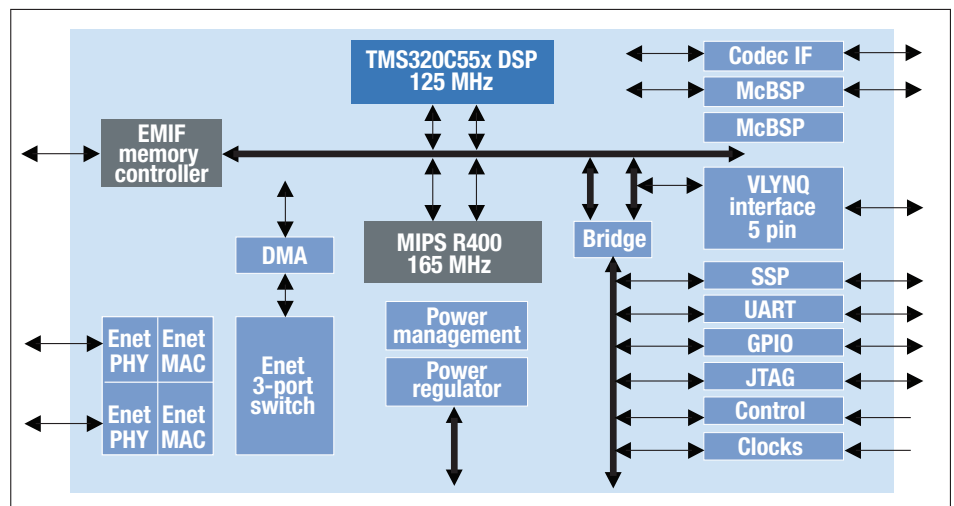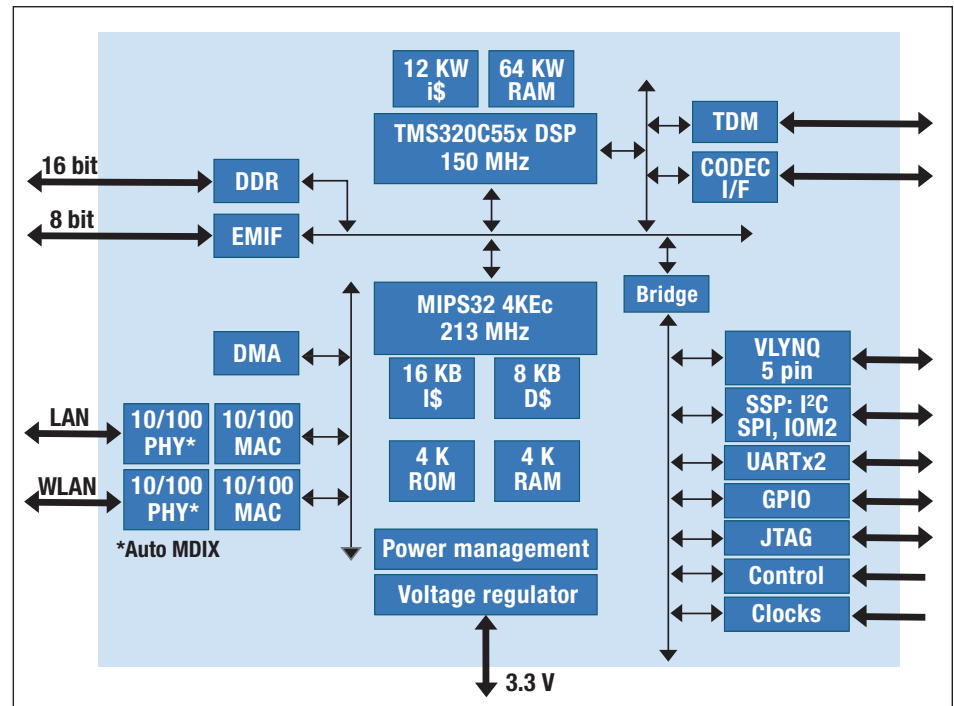
TNETV1060

▲ TNETV1060 block diagram

TNETV1061 key features:

- SoC integrating:
  - C55x DSP core operating at 150 MHz
  - MIPS 4KEc core operating at 212 MHz
- Channel densities:
  - 4 LBR or T.38 fax relay channels
  - 32-ms echo canceller
- Memory:
  - DSP: 64-KWords RAM / 12-KWords I-Cache
  - MIPS: 16-KB I-cache / 8-KB D-cache
- System interfaces:
  - Two 10/100 Ethernet MAC/PHY with Auto MDIX
  - 16-bit DDR memory interface
  - Five-pin VLYNQ communications interface
  - NAND/NOR flash memory interface
  - 2 UART
  - TDM, SPI, PCM for four voice channels
- EVM available
- Packaging: 255 BGA

Telogy Software™ products for VoIP

TI's Telogy Software products provide the broadest range of VoIP features available. As new TI device architectures evolve, so too do Telogy Software features to take advantage of new system interfaces and performance.

Key software capabilities include:

- Voice processing for PSTN to packet gateway applications
- T.38 fax relay
- Conference bridge
- Signaling
- Voice and call quality management

With the largest installed base of field-hardened gateway-specific solutions since 1995, Telogy Software provides world-class VoIP software solutions that industry giants rely on. Every level of VoIP product benefits from the breadth of the software deployments and improvements.

Voice

VoIP software processes voice samples for transmission over a data network. There are many functions included in good quality VoIP software. Its sub-components perform echo cancellation, voice compression (to conserve bandwidth), voice-activity detection, jitter

TNETV1061

▲ *TNETV1061 block diagram*

removal and voice packetization.
VoIP consists of the following functions:

- Voice codec support, including G.711, (PCM), G.723.1A, G.726 (ADPCM), G.729AB, G.729E, iLBC, G.722, etc.
- Line echo cancellation: G.168 – 2004 line echo canceller NLP, double talk, 8-128-ms echo tail
- Voice activity detection (VAD)
- Comfort noise generation (CNG)
- Packet play-out: delay, jitter and lost packet concealment/recovery
- In-band tone detection and generation
- Configurable packetization: RTP or RTP/UDP/IP

T.38 fax relay

Fax relay provides reliable real-time fax service between two analog fax machines over a packet network. The equipment at both ends of the packet network spoofs the analog fax machines such that they operate as if directly connected over a PSTN connection. The equipment performing fax relay functions must handle the effects of network delay, jitter (variable delay) and lost packets while preventing the fax machines from timing out. In addition, forward error correction and advanced error concealment techniques are employed to improve document quality.

Fax relay consists of the following functions:
- Fax modem pumps: V.17, V.29, V.27ter, V.21
- Fax relay protocol: T.38 (TCP/IP)
- Fax machine spoofing protocols: proprietary
- T.30 protocol support

Signaling

Gateway platforms must support signaling for call establishment, in-band signaling and call termination. Both channel associated signaling (CAS) and common channel signaling (CCS) are employed by networks and must be supported.

The following signaling functions are supported and run on a combination of the DSP and an external host processor:
- Tone detection and generation, e.g., DTMF, MF, call progress, etc.
- Caller ID detection and generation (Bellcore, ETSI, NTT)
- Message-based signaling support, e.g., transparent, HDLC, ISDN, etc.
- Transparent and switched-mode signaling, including in-band and out-of-band relay voice and call quality management

Gateway software

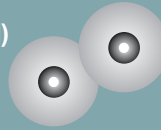| Example vocoders	Packetization	Software framework
– G.711 – G.726 – G.729AB – G.723.1A – iLBC – G.722	– RTP or TRP/UDP/IP – Configurable packetization – Voice activity detection – Comfort noise generations – Packet playout (jitter buffer) – Packet loss concealment – Packet loss recovery	– Real-time scheduler – Multi-channel, multi-function – Intelligent memory/MIPS management – Hardware abstraction layer (HAL)
Full-feature POTS – Complete tone detection/generation – Country-specific caller ID detection and generation – Conferencing – CAS/CCS signaling support – Announcement services – T.38 fax relay	**Voice quality management** – Field diagnostics – Extensive statistics – Status monitoring – Voice quality monitoring (VQM)	**Echo cancellation** – G.168 – 2004 line echo canceller NLP, double talk, 8-128 ms echo tail

▲ *Telogy Software solutions for VoIP gateway software features*

Voice and call quality management

Fundamental to any communications system is the ability to discover, isolate and remedy problems as quickly as possible to minimize or eliminate the degree to which users are impacted. VoIP networks must support telco-grade management and diagnostics for wide-scale, cost-effective deployments.

TI's voice and call quality management features include:
- Real-time measures such as mean opinion score (MOS) estimation based on delay, jitter and packet loss statistics
- Support for RFC3611 Real-Time Protocol Extended Reports (RTCP XR)
- Detailed call statistics for fax, tone detection, echo, error stats and packet stats
- Diagnostic tools for detailed troubleshooting: trace, fax, echo, TDM or packet interfaces, analog line tests
- Alerts/alarms with configurable thresholds
- Optimized adaptive jitter buffer, packet loss concealment and redundancy

Telogy Software architecture

Figure 1 describes the software architecture for gateway solutions. Each box represents a software component required to implement the features for voice, fax, modem, signaling and network management functions.

Multiple instances of each software component can exist to facilitate support of concurrent, multi-channel operation. Each instance shares common program memory and has unique channel-specific data memory to maintain information regarding the state of the channel, including network management and diagnostic information.

Features: Telogy Software products for CPE gateway solutions

Please note: The exact combination of features varies on a build-to-build basis.

Voice and fax features:
- G.711 PCM 64 Kbps
- G.723.1 5.3/6.3 Kbps and Annex A (silence compression)
- G.726 ADPCM 16, 24, 32, 40 Kbps
- G.727 ADPCM
- G.729 8 Kbps
- G.729 AB 8 Kbps (Annex A and B – VAD, CNG)
- G.729 Annex E 11.8 Kbps
- iLBC
- G.722
- G.165/G.168 echo cancellation
- Packet playout unit (de-jitter buffer, lost packet compensation)
- Voice activity detection (VAD) silence suppression
- Comfort noise generation (CNG)
- Comfort noise level control
- RTP packet encapsulation for voice
- DTMF relay
- DTMF detection during voice mode
- Configurable call progress detection parameters
- Configurable voice packetization rates
- V.17 at 7,200, 9,600, 12,000 and 14,000 bps
- V.27ter at 2,400 and 4,800 bps
- V.29 at 7,200 and 9,600 bps
- Fax pass-through (PCM)
- T.38 real time fax relay
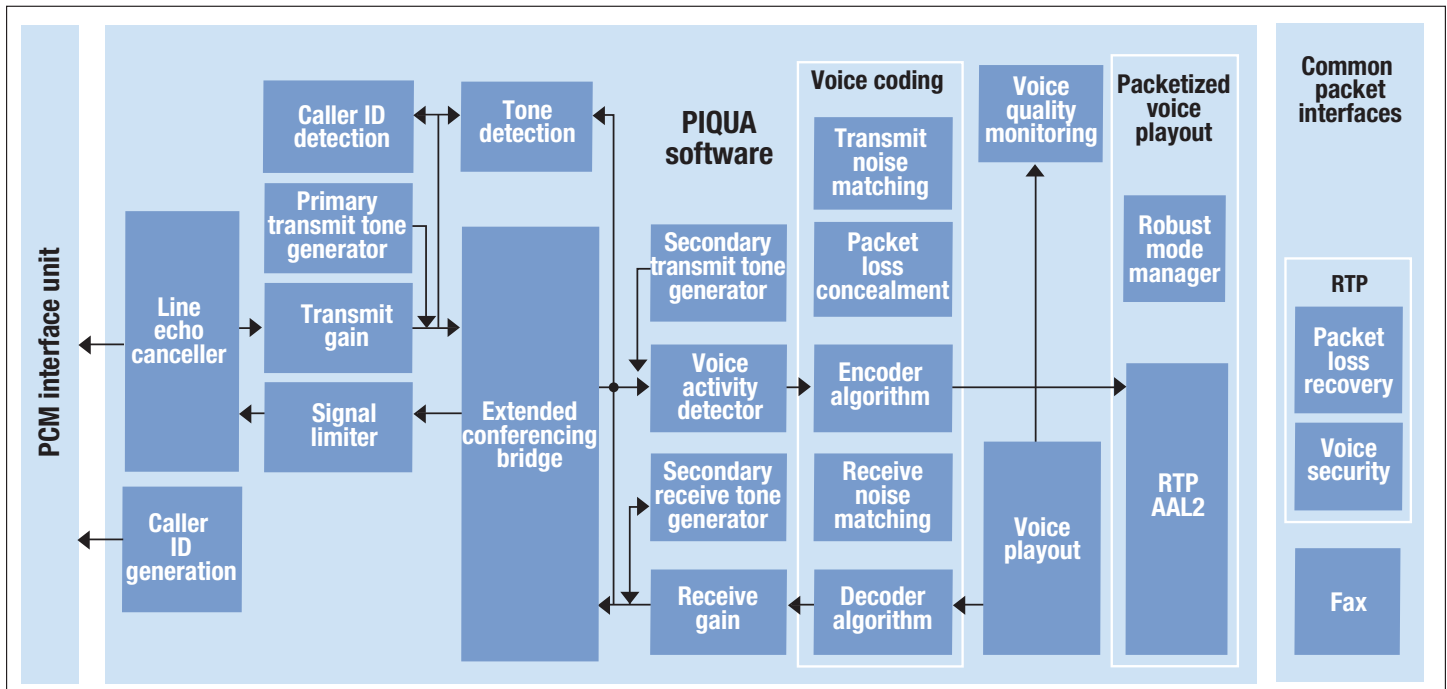
▲ *Telogy Software architecture*

- In-band signaling
- DTMF generation/detection
- MF R1, R2 tone generation/detection
- CP tone detection for T1 CAS
- SS7 ring-back tone generation
- SS7 COT
- API support (management, event monitoring/reporting, statistics)
- Telchemy VQmon support
- Loopback test capabilities
- Core dump facility
- Memory read/write support
- Trace messages
- Side tone detectors (EDT, Baudot, V32EXT)
- Address Resolution Protocol (ARP) support
- ICMP echo (ping) support
- Enhanced packet routing
- Voice quality management enhancements (PIQUA™ software Multimedia Agent, PIQUA System Agent)
- Telephony control over packet/MII

TEXAS INSTRUMENTS

SPAT180A