Freescale Semiconductor
Solution Guide

SME8360EWP
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Using the PowerQUICC™ II Pro MPC8360E to Build Small and Medium Enterprise Routers

Small and medium enterprise (SME) routers, also known as business gateways, are utilized by companies such as remote office banks, regional utility company offices, retailers, insurance company call centers and other small and medium sized enterprises. SME routers provide internet connectivity. They can be used to extend the corporate intranetwork to a remote or branch office environment or provide mobile workers secure access to the network. Consequently, a key requirement is to provide internal local area networking (LAN) and wide area networking (WAN) communication traffic handling over a secure Internet Protocol (IP) packet based network. An overview of how SME routers are utilized in the network is illustrated in Figure 1.

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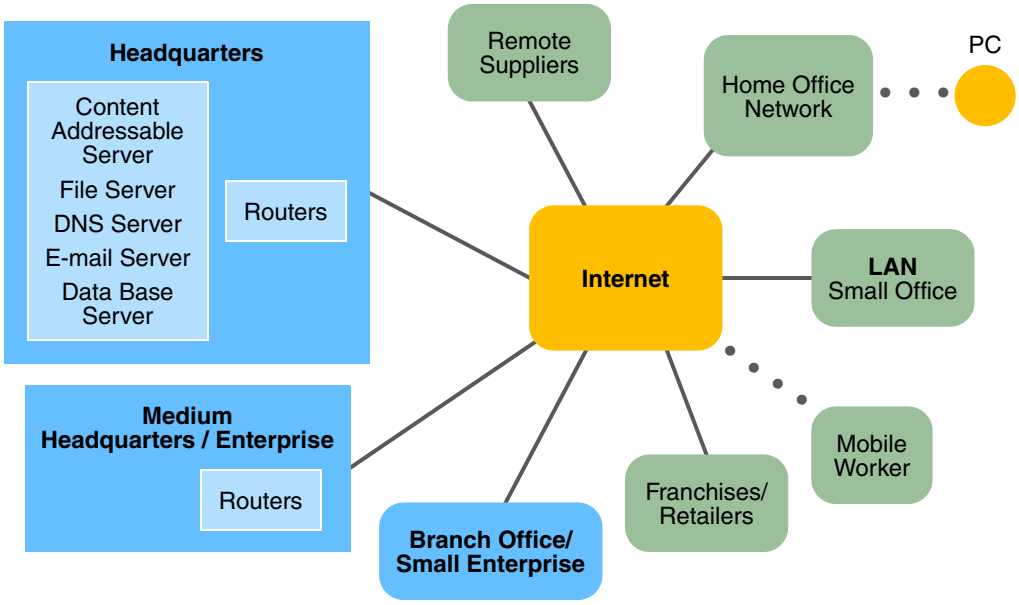

Figure 1. Overview of SME Routers Utilized in a Network

Suppliers of SME routers must provide a broad range of products to address the needs of their customers and provide a path for expansion as a business grows. Some products have a fixed chassis, others are modular, using different blades in the product to scale and upgrade features. The market requirements that any solution must be able to address include the ability to offer plug-and-play installation, mobility, triple play services (voice, data, and video), advanced routing, extensive virtual private networking (VPN) and security capabilities, stateful packet inspection and firewall, quality of service and bandwidth management coupled to modular WAN and LAN options.

1 Design Challenges

Manufacturers of SME routers must provide solutions that support triple play services of voice, data, and video over secure IP (IP-VPN) based packet networks that can scale in bandwidth and number of users at a cost competitive price.

In this respect one of the key enablers is IP. Eventually, it will become universal across both private and public networks. Until then, equipment that uses these networks must support the convergence of inter-operability between circuit and packet-switched networks and between many standards and protocols. This is particularly true of WAN protocols and standards towards the public network. Hence, a key design challenge is network evolution, not revolution providing interoperability in terms of existing routing, authentication, and directory and security services.

The ability to support a number of users is important. Typically in the smallest office/home office routers, the number of users is five or less, whereas small offices can scale from five to thirty users and medium sized offices can scale from twenty to one hundred and fifty users. SME routers must be capable of supporting fixed and modular configurations at a cost-effective price that meet physical size requirements and have low power dissipation.

Virtual private networking and security are hallmarks of any high quality SME router. The ability to deny access to the public network (secure routing), except via secure management tunnels, is vital in protecting intellectual property. Standard-based tunnelling is also important, so support for IP-Sec, L2TP, PPTP and L2F standard tunnelling protocols provides interoperability with a wide range of multi vendor VPN software and hardware.

Encryption support for algorithms like DES, 3DES, and the Advanced Encryption Standard (AES) provides ultimate end-to-end security for transmitted data.

Authentication support for protocols like RADIUS, LDAP, secure ID, and X509 as well as token and smart card support and directory-based services are important factors for SME routers.

Stafefull firewall and secure routing services using standard protocols like Open Shortest Path First (OSPF), Routing Information Protocol (RIP), Network Address Translation (NAT), and industry standard data link switching services to transport traffic over the public or private IP networks, using the encryption and tunnelling protocols discussed previously, also need to be considered.

Bandwidth management and Quality of Service (QoS) provide the ability to deliver on the promise of highly optimized IP networks. With advanced services—Differentiated services (Diffserv) and other sophisticated queue management—it is critical that an SME router ensure service levels are met for any mission-critical data. Hence, solutions must support the prioritization of traffic not only by IP traffic type, but also by prioritized users, groups and VPN tunnels allowing for a very fine granularity in (QoS) and even Class of Service (CoS) must be supported. Also in multi-user environments the ability to support minimum guaranteed bandwidth for a user or set of users.

LAN/WAN flexibility to support Ethernet, frame relay, PPP, T1/E1, V35, X21, ADSL, VDSL, ISDN, V90 as well as wireless broadband connectivity such as 802.11 and even over time 802.16 will become key requirements. On the WAN side, the main layer two protocols used are frame relay (FR), asynchronous transfer mode (ATM) AAL5 over ADSL, integrated services digital networks (ISDN), dial up, and leased line. On the Lan side, the main layer two protocol used is Ethernet and the key requirement is to eliminate the need for an Ethernet switch or hub in a small office environment, while medium sized offices may include an Ethernet switch or hub. In addition, wireless LAN 802.11 can also be deployed to provide mobility to users within the office environment.

In summary, the specific design challenges for SME routers include the following:

- Increasing number of different network interfaces
- Convergence towards IP packet based networks.
- Switching, interworking, parsing, and forwarding of multiple protocols
- Managing bandwidth and QoS to ensure prioritization of latency sensitive traffic, such as voice or guaranteed bandwidth per user
- Excellent virtual private networking and advanced security features that support legacy and new emerging standards and requirements
- Providing flexibility to add new features and functions through in-field software upgrades as market demands dictate

The successful SME solution must provide a balance among system implementation, power dissipation, physical size, Printed Circuit Board (PCB) area coupled to system performance, the appropriate software, and cost effectiveness. However, equipment manufacturers face the challenge of providing more system performance, flexibility, and features without inflating system costs, power dissipation, or PCB area. As a result, a cost-effective alternative to expensive ASICs, FPGAs or NPUs is needed to meet these demands.

2 Freescale Semiconductor Solutions

In the competitive SME router market, highly integrated, cost-effective and scalable system solutions are required. With these system requirements in mind, Freescale is pleased to introduce the latest addition to its popular PowerQUICC family of microprocessors—the PowerQUICC II Pro MPC8360E.

The MPC8360E incorporates the e300, 603e core which includes 32 Kbytes of L1 instruction and data caches, 32-bit PCI bridge, four DMA channels, USB support, dual 32-bit DDR memory controller, a double precision floating point unit and on-board memory management units. A block diagram of the MPC8360E is shown in Figure 2.

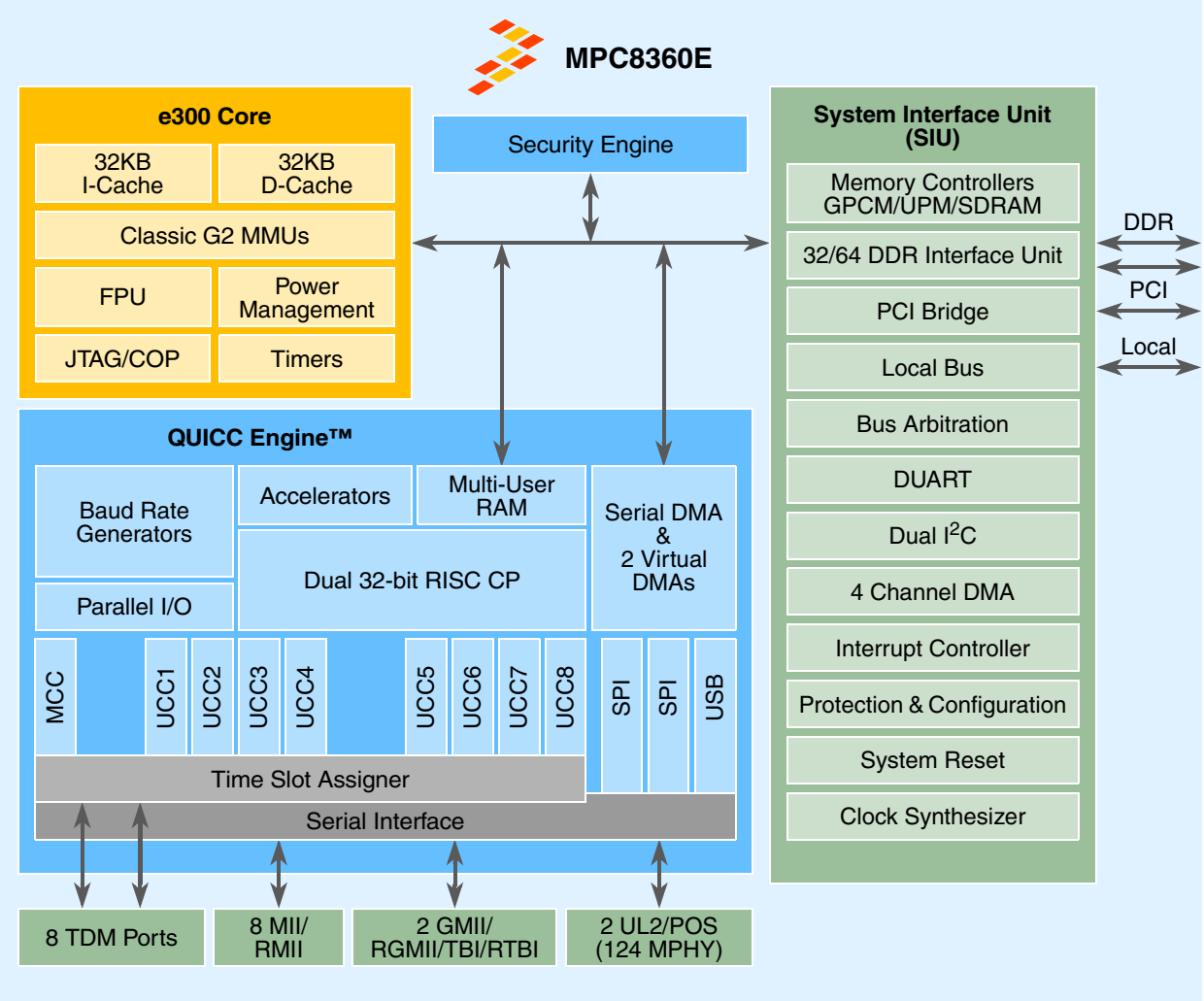

Figure 2. MPC8360E Block Diagram

A new communications complex—the QUICC™ Engine—forms the heart of the networking capability of the MPC8360E. The QUICC Engine contains several peripheral controllers and integrates two 32-bit RISC controllers. Each RISC controller can control multiple peripherals and work together to provide increased aggregated system bandwidth for higher throughput applications. Protocol support is provided by the main workhorses of the device—the unified communication controllers (UCCs) and multi-channel communication controller (MCC).

Each of the eight UCCs can support a variety of communication protocols: 10/100/1000 Mbps Ethernet through a Media-Independent Interface, ATM / POS PHY support up to OC-12 speeds, Serial ATM, Multi-PHY ATM, HDLC, UART, Multi-Link/Class PPP, BISYNC and 64 TDM channels. Each MCC is capable of supporting up to 256 TDM channels in either transparent or HDLC channel modes and multiplexing almost any combination of sub-groups into a single or multiple TDM stream. Inverse Multiplexing over ATM is supported and allows ATM traffic to be distributed across multiple E1/T1 circuits. This allows service providers to lease the exact bandwidth that subscriber's request.

In addition, the QUICC Engine can also support two UTOPIA level 2 or two POS interfaces, each interface capable of supporting 124 Multi-PHY, or up to two, 128 Multi-PHY interfaces using extended address mode. The QUICC Engine also features an integrated 8-port, L2 Ethernet switch which can provide 4 priority levels on each port, VLAN functionality, IGMP snooping, network auto-negotiation function, store-and-forward switching and packet-error filtering. Enhanced interworking features within the QUICC Engine helps offload the main CPU. The QUICC Engine can provide ATM-to-ATM switching, Ethernet to ATM switching with L3 / L4 support and PPP interworking.

The MPC8360E's security engine allows CPU-intensive cryptographic operations to be offloaded from the main CPU core. The security-processing accelerator provides hardware acceleration for the DES, 3DES, AES, SHA-1, MD-5, and ARC-4 algorithms. It includes a public key accelerator and an on-chip random number generator.

In summary, the MPC8360E provides SME router vendors with a highly integrated, fully programmable communications processor that allows reuse of existing legacy PowerQUICC II and III software drivers and microcode packages. This helps ensure that a low cost system solution can be quickly developed and will offer flexibility to accommodate new standards and evolving system requirements.

2.1 The PowerQUICC II Pro MPC8360E

The PowerQUICC II Pro MPC8360E is a high performance, highly integrated communication processor solution that offers the following.

2.1.1 MPC8360E Features

- High-performance, low power (< 5W typical power dissipation), and cost-effective communications processor
- The MPC8360E QUICC Engine offers a future proof solution for next generation designs by supporting programmable protocol termination, network interface termination, and interworking features to meet evolving protocol standards
- Single platform architecture supports the convergence of IP packet networks and ATM networks, including interworking between these networks
- Simplified network interface card design with a cost-effective single chip data plane/control plane solution for ATM or IP packet processing (or both). This reduced component count, board power consumption and board real estate.
- Universal network interface card design for multiple applications, which lowers costs and reduces time-to-market
- Built-in proprietary, hardware accelerators that accelerate data plane traffic, such as interworking, and control plane packet snooping, such as IGMP, VLAN tagging, DHCP, and so on
- DDR memory controller—one 64-bit or 2x32-bit interfaces that split data and control plane traffic at up to 333 MHz
- e300 PowerPC core (enhanced version of 603e core with 32K bytes of Level 1 Instruction and 32K bytes of Level 1 Data caches)
- 32-bit PCI interface
- 32-bit Local Bus interface
- USB
- Integrated 8-port L2 Ethernet switch
  - 8 connection ports of 10/100 Mbps MII/RMII & one CPU internal port

  - Each port supports four priority levels
  - Priority levels used with VLAN tags or IP TOS field to implement QoS
  - QoS types of traffic, such as voice, video, and data
- The security engine provides termination or encrypted plane traffic
- High degree of software compatibility with previous-generation PowerQUICC processor-based designs for backward compatibility and easier software migration
- Seamless connection to PowerQUICC III family devices for increased control (CPU) application processing requirements

2.1.1.1 Protocols

- ATM SAR up to 622Mbps (OC-12) full duplex, with ATM traffic shaping (ATF TM4.1) for up to 64K ATM connections
- Support for ATM AAL1 structured and unstructured Circuit Emulation Service (CES 2.0)
- Support for IMA and ATM Transmission Convergence sub-layer
- ATM OAM handling features compatible with ITU-T I.610
- PPP, Multi-Link (ML-PPP), Multi-Class (MC-PPP) and PPP mux in accordance with the following RFCs: 1661, 1662, 1990, 2686 and 3153
- IP termination support for IPv4 and IPv6 packets including TOS, TTL and header checksum processing
- L2 Ethernet switching using MAC address or IEEE 802.1P/Q VLAN tags
- Support for ATM (AAL2/AAL5) to Ethernet (IP) interworking
- Extensive support for ATM statistics and Ethernet RMON/MIB statistics.
- Support for 256 channels or HDLC/Transparent or 128 channels of SS#7

2.1.1.2 Serial Interfaces

- Support for two UL2 / POS-PHY interfaces with 124 Multi-PHY addresses each.
- Support for two 1000Mbps Ethernet interfaces using GMII or RGMII, TBI, RTBI.
- Support for up to eight 10/100Mbps Ethernet interfaces using MII or RMII
- Support for up to eight T1 / E1 / J1 / E3 or DS-3 serial interfaces
- Support for dual UART, I²C and SPI interfaces.

System scalability is also made available through the number of UCCs and MCCs. The initial implementation offers eight UCCs and one MCC, however as a result of the system-on-a-chip design methodology used for the QUICC Engine, these numbers can be scaled to support an optimized mix of communications channels. The flexible architecture of the QUICC Engine allows customers to customize their own application protocol and filtering requirements, allowing Freescale to add more RISC engines and/or UCCs on future family derivatives.

2.2 Development Environment

Development tools, hardware platforms, software building blocks and application-specific software solutions are available from Freescale and our Freescale Alliance Program, including third party protocol and signaling stack suppliers, real time operating systems support and a variety of applications software support. All of this builds upon the existing industry standard PowerQUICC family support program.

2.2.1 Software Development Tools

To simplify and accelerate the development process, Freescale will provide a user-friendly, integrated development environment (IDE), which includes a compiler, instruction set simulator and debugger for the e300 PowerPC core.

2.2.2 Application Development System (ADS)

Freescale provides an ADS board as a reference platform and programming development environment for the MPC8360E with a complete Linux Board Support Package. The ADS board will support on-board DDR SDRAM memory, a PCI interface, and a debug port and can be configured with optional daughter cards supporting protocols such as OC-3 or OC-12 ATM, 8xT1/E1 and Ethernet (10/100/1000Base T).

Also available is a complete development system based around the AdvancedTCA (ATCA) form factor chassis with a choice of AMC cards that can be operate stand alone, or as modular inserts into the main processor baseboard. This allows maximum flexibility for prototyping wireless network interface, control and base band applications using Freescale silicon solutions.

2.2.3 Modular Software Building Blocks

The QUICC Engine will be supported by a complete set of configurable device API drivers and initialization software. Figure 3 shows the wealth of software protocols that the QUICC Engine with the e300 PowerPC™ core is able to provide.

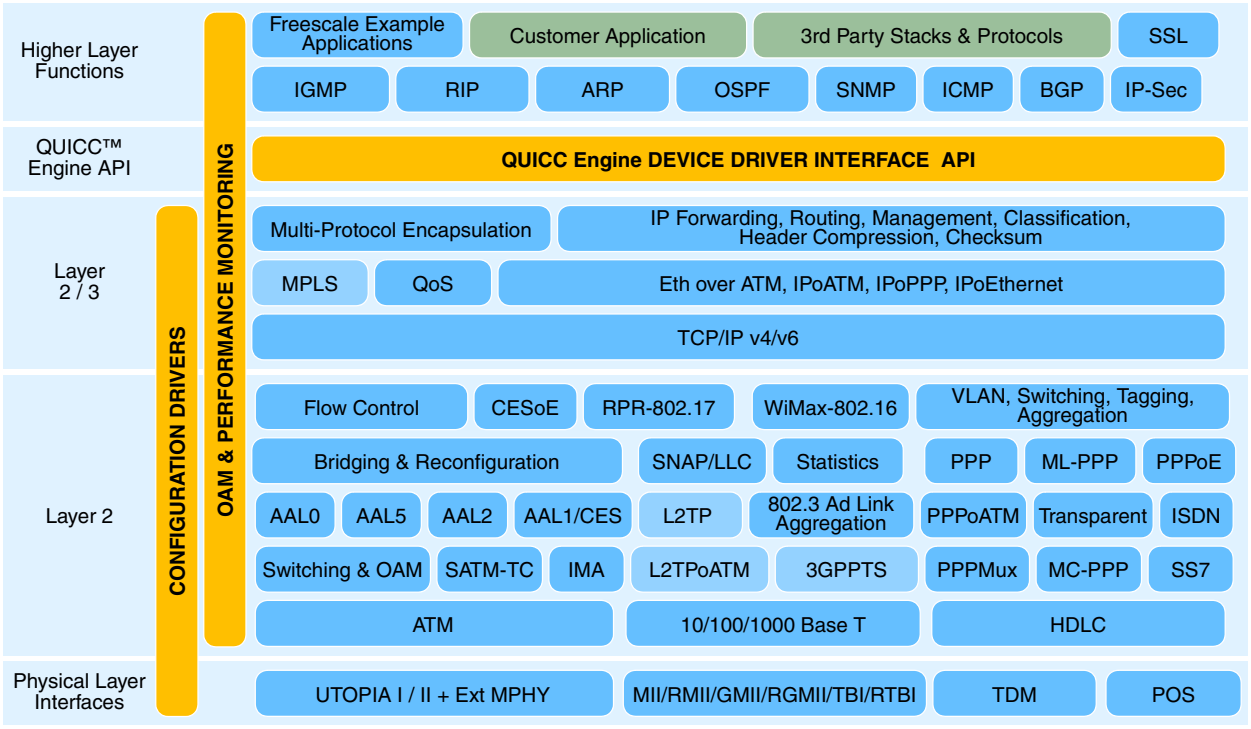

Figure 3. Software Protocol Support for the QUICC Engine

3 Application Example

The internal features and protocols supported by the MPC8360E allow a wide range of different network solutions to be developed. Figure 4 illustrates how a typical SME router application can be realized with the MPC8360E.

In this application the MPC8360E provides all of the processing, protocol, and interworking functions required to implement the SME Router. Specifically, the QUICC Engine is used to carry voice, data and video using IP over the LAN and WAN interfaces. On the LAN side, four UCCs are used to provide 10/100 fast Ethernet switching capabilities. Two Gigabit Ethernet interfaces are used for uplink. Two of the TDM interfaces are used to support HDLC, which provides a leased line E1/T1 connection or an ISDN connection. One UCC is used as an ATM interface supporting AAL5 cell Saring for dial up ADSL connection, while the last UCC can be configured as serial (UART) or Ethernet (MII) for debug and control.

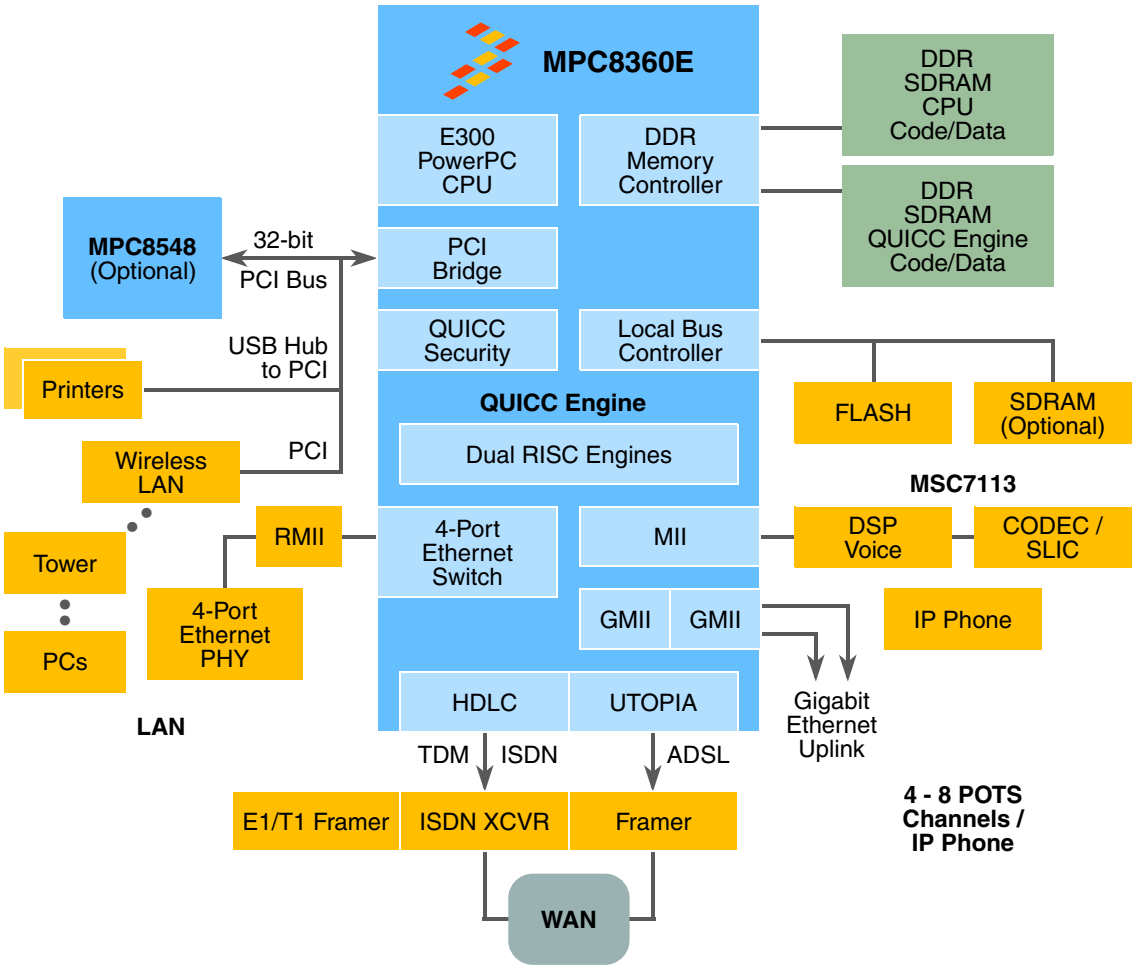

Figure 4. SME Router Using MPC8360E

Alternatively, the remaining UCC of the MPC8360E could be used to support an Ethernet connection to a low cost digital signal processor (DSP) such as the MSC7113 family of DSPs based on StarCore technology supporting 4 to 8 voice ports, which can be for plane old telephone system (POTS) telephones or for IP based telephones using a combination of premium voice algorithms such as G729a/b, G723.1 or G71.1. For very high-density voice ports, the MSC8122 DSP can be used via an Ethernet interface.

In this type of application, the QUICC Engine of the MPC8360E uses its internal interworking features to offload the e300 CPU and accelerate data plane functions including mapping of ATM based on the VPI/VCI to IP/UDP ports based on the MAC or VLAN addresses.

The main system memory is provided by a dual 32-bit DDR SDRAM controller, which allows equipment providers to partition system parameters and data in an extremely efficient manner. One 32-bit DDR memory can be used for control plane processing (code/data) and the other could be allocated for data plane processing (code/data). The local bus can be used for optional SDRAM or on-board FLASH EPROM.

The MPC8360E PCI controller can be used to interface to an optional PowerQUICC III MPC8548 device if additional CPU processing power is required. The MPC8548 supports an e500 PowerPC core up to 1.33GHz with 32Kbytes of L1 instruction and data cache and 512Kbytes of L2 cache which can also be used as a SRAM. The need for such additional CPU processing performance in an SME router is dependent upon customer system requirements. The CPU within the MPC8360E provides over 1200 MIPS of processing performance, which will be sufficient in many cases when combined with the parallel communication capability of the QUICC Engine. However, the ability to provide additional CPU processing performance enables an SME router to quickly evolve to a large enterprise router while reusing the same software development.

Other interfaces connected to the PCI bus can include a four-port universal serial bus (USB) hub for connecting equipment such as printers, copiers, scanners and system back up disk. In addition, a wireless LAN interface can be connected to the PCI bus supporting 802.11-a/b/g/n connectivity within the office environment.

Finally, the security engine provides acceleration for encryption, authentication, and standards based tunnelling as required by IP-Sec.

4 Summary

The PowerQUICC II Pro MPC8360E with the new QUICC Engine is a significant step forward in performance, integration and cost effectiveness for a wide variety of application. For flexible, high performance, SME routers, the MPC8360E offers a comprehensive feature set that enables cost effective solutions with an unrivalled level of versatility to evolve as both standards and the system requirements change.

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