

Using the PowerQUICC™ II Pro MPC8358E 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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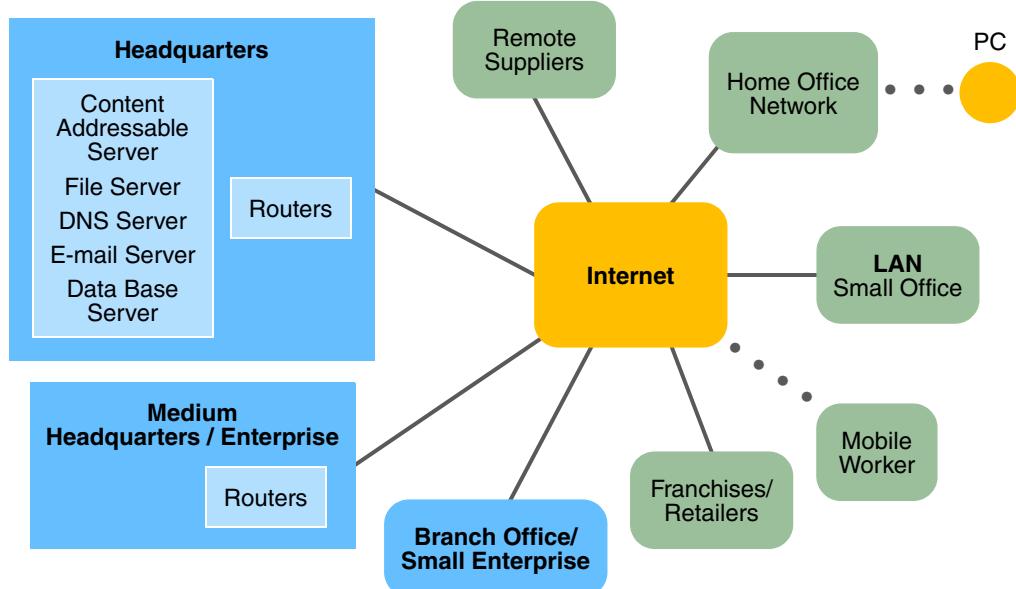


Figure 1. Overview of SME Routers Utilized in a Network

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.

Statefull 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 MPC8358E.

The MPC8358E incorporates the e300, 603e core which includes 32 Kbyte 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 MPC8358E is shown in [Figure 2](#).

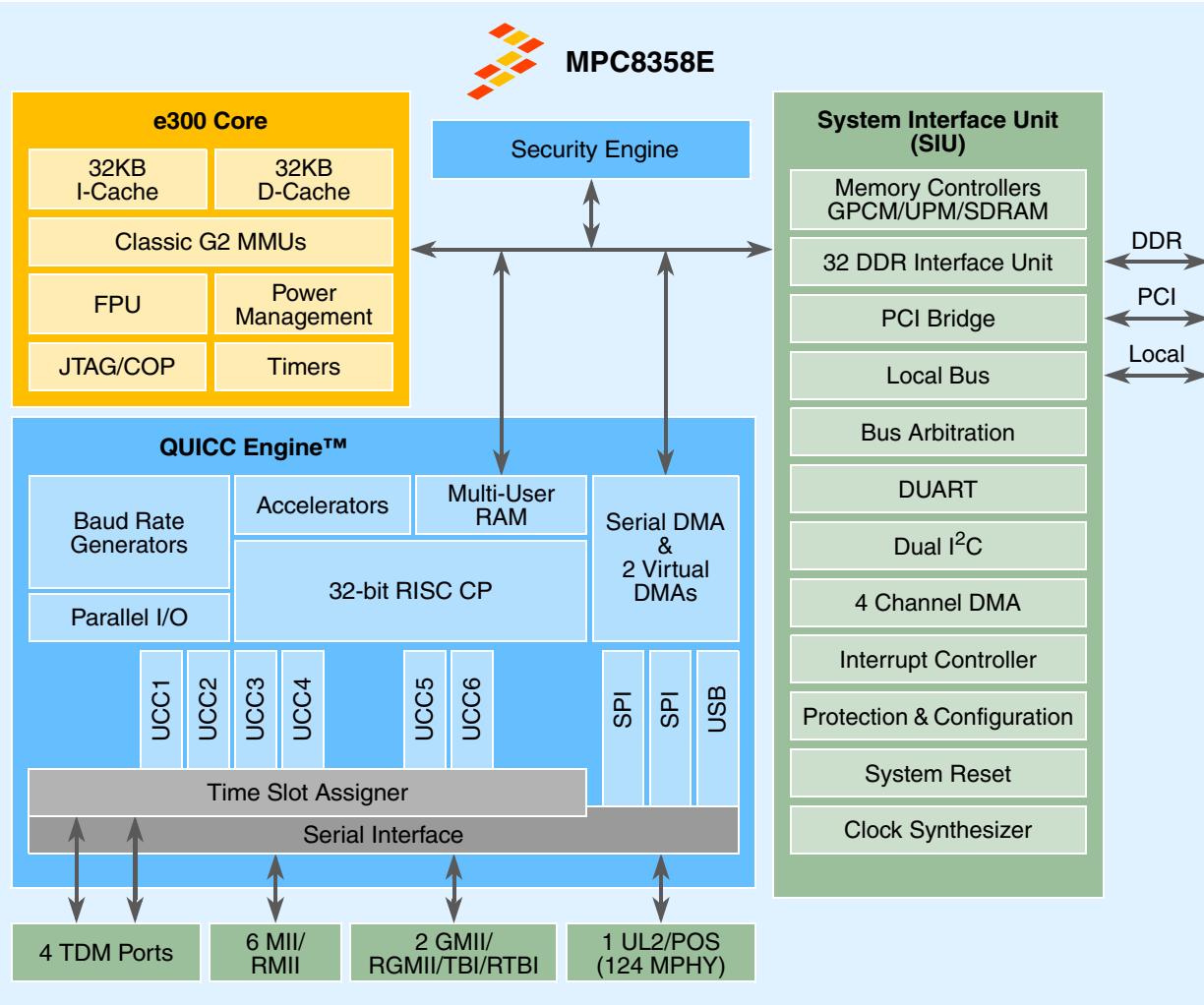


Figure 2. MPC8358E Block Diagram

The MPC8358E incorporates a new communications processor module referred to as the QUICC Engine™, which supports a wide range of protocols and new high speed interfaces. Additional enhancements include the e300 PowerPC core complex with 32 Kbytes of instruction and data cache, a dual 32-bit DDR memory controller, a 32-bit PCI bridge, four DMA channels, USB support and an integrated security engine.

Flexibility in the QUICC Engine is ensured by the six unified communication controllers (UCCs) providing support for Fast Ethernet, Gigabit Ethernet, HDLC, and ATM /Packet over SONET (POS) at up to OC-12 speeds. Four TDM interfaces enable connection to four TDM links running at T1/E1 line rates or more. The UCCs can also be used to support up to 6 T3/E3 connections.

In addition, the QUICC Engine can also support one UTOPIA level 2 or one POS-PHY interfaces, capable of supporting up to 124 Multi-PHY. The QUICC Engine also features an integrated 4-port, L2 Fast Ethernet switch which can provide 4 priority levels on each port, Virtual LAN (VLAN) functionality, IGMP snooping, network auto-negotiation function, store-and-forward switching and packet-error filtering.

Enhanced interworking features is supported on the QUICC Engine to help offload the main CPU with tasks normally handled in user application software. The QUICC Engine is capable of providing ATM-to-ATM switching (AAL0, 2, 5), Ethernet-to-ATM switching with L3 / L4 support, and PPP interworking.

The MPC8358E'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.

The MPC8358E has a single DDR memory controller and both the e300 and QUICC Engine can access this memory controller.

In summary, the MPC8358E 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 MPC8358E

The PowerQUICC II Pro MPC8358E is a high performance, highly integrated communication processor solution that offers the following.

2.1.1 MPC8358E Features

- MPC8358E QUICC Engine offers a future proof solution for next generation SME routers by supporting: programmable protocol termination, hardware interfaces and interworking features to meet evolving protocol standards.
- Independent, integrated, multi-RISC QUICC Engine provides extensive protocol handling, management and manipulation without host processor intervention thereby freeing the CPU core for higher-level applications tasks.
- Single platform architecture supports the convergence of IP packet networks and ATM networks, including interworking between them.
- Simplified SME Router design with a cost-effective single chip solution for LAN and WAN packet processing, thus reducing component count, board power consumption, board real estate, lowering costs and reducing time-to-money.
- 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
- A 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 128 channels or HDLC/Transparent via QUICC Multichannel Controller (QMC) microcode

2.1.1.2 Serial Interfaces

- Support for one 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 six 10/100Mbps Ethernet interfaces using MII or RMII
- Support for up to six 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 UCCs. The initial implementation offers six UCCs, 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 MPC8358E 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.

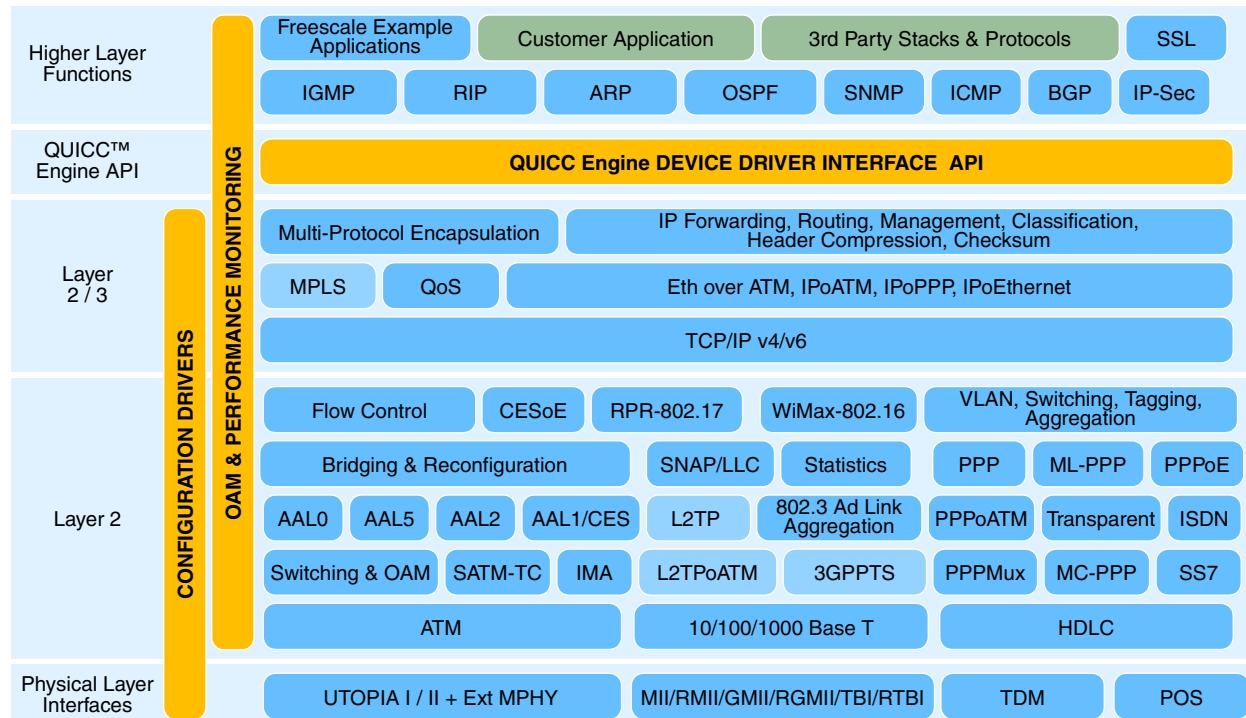


Figure 3. Software Protocol Support for the QUICC™ Engine

3 Application Example

The internal features and protocols supported by the MPC8358E allow a wide range of different network solutions to be developed. [Figure 4](#) illustrates a typical SME router application with the MPC8358E.

In this application the MPC8358E 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, one UCC is used to connect to an external 4-port or 8-port Ethernet switch. 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.

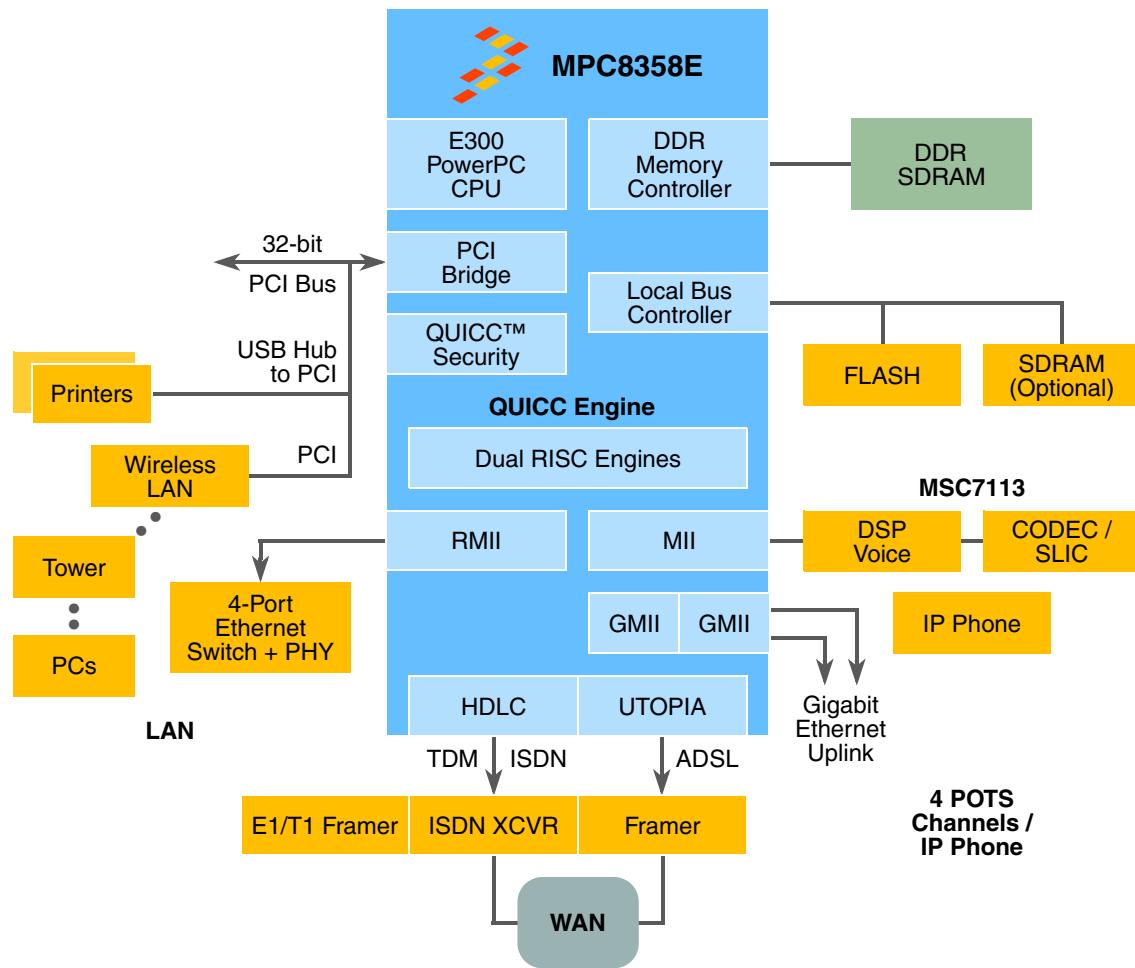


Figure 4. SME Router using MPC8358E

Alternatively, the remaining UCC of the MPC8358E can 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 typically 4 to 8 voice ports, which can be for plane old telephone system (POTS) telephones or for IP based telephones using premium voice algorithms like G729a/b or G723.1 or G711 or a combination their off.

In this type of application, the QUICC Engine of the MPC8358E makes use of 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.

A single 32-bit DDR SDRAM controller supports the main system memory. The local bus can be used for optional SDRAM or on-board FLASH EPROM.

In low cost SME routers, the PCI bus can include support for 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 like IP-Sec.

4 Summary

The PowerQUICC II Pro MPC8580E with the new QUICC Engine is a significant step forward in performance, integration and cost effectiveness for a wide variety of applications. For flexible, high performance, SME routers, the MPC8358E 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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