Introduction

Emergency communication systems (ECS) are organized for the primary purpose of supporting one-way and two-way communication of emergency messages between both individuals and groups of individuals. One of the most commonly found ECS is the emergency phone system on highways. Similar emergency phones are also used on campuses, parking garages, elevators, buildings, and industrial applications (an example campus ECS is shown in Figure 1). Individuals use these in case of accidents, medical emergencies, and issues of personal safety. These systems are typically connected to an answering station that responds to caller's emergency. For example, police, firefighting, and ambulance services are connected to a Public Safety Answering Point (PSAP) operated by the city or county. These systems can also be used for public announcement and paging while they are on standby for emergency situations.

IP-Based Emergency Systems

In recent year, ECS are evolving into IP-based systems. For example, design of the Next Generation 911 system (NG911) relies on an Emergency Services IP Network (ESInet) to deliver voice, video, text and data "calls" to the PSAP. The protocol used for delivering these "calls" is the Session Initiation Protocol (SIP), or IP Multimedia Subsystem (IMS, which incorporates SIP). The functional and interface standards developed by NENA describe general SIP and IMS-based architectures that allow responsible agencies flexibility in developing an infrastructure to support the envisioned features of NG911. Building managers are also moving to IP-based emergency notification systems to leverage Local Area Networks (LAN) already installed in their buildings.

Figure 1. A campus Emergency Communication System

In response to these trends, manufacturers of emergency systems are changing their products to meet customer demand, evolving from traditional analog systems to IP-based products to leverage widespread innovation in communication systems and to make them ready for Cloud services.

For example, Figure 2 shows a block diagram of an IP-based highway emergency system. The phones of the system are now VoIP-enabled and connected to the PSAP via a Wide Area Network (WAN). In addition, the PSAP is also connected to the Internet and can handle "calls" from smartphones. Vendors are also providing support for 911 services for IP Phones by providing the connection between the caller's phone location and appropriate public safety location.
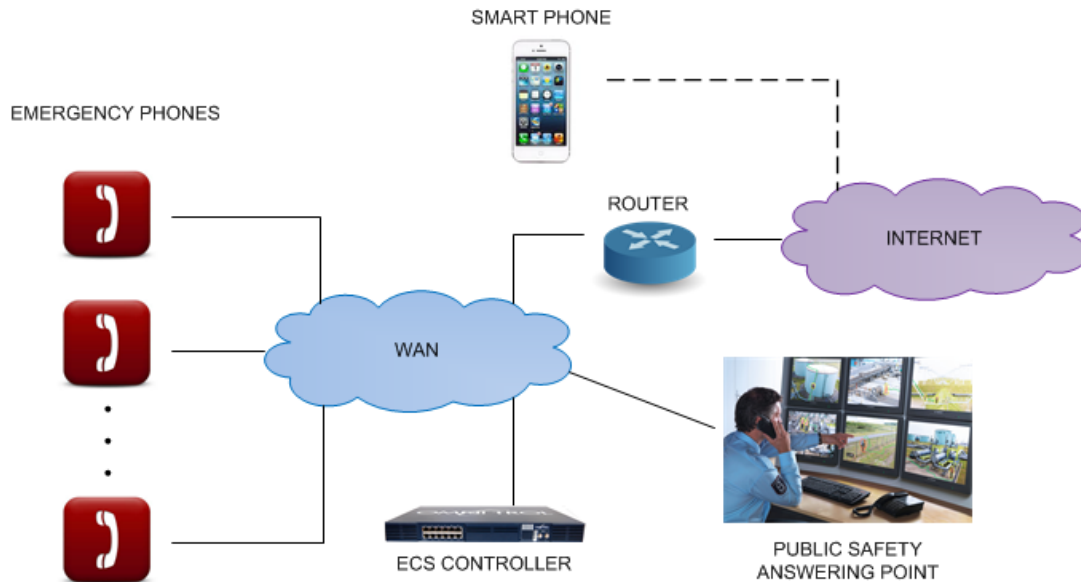

Figure 2. Example of an IP-Based Emergency Communication System

Features of IP-Based Emergency Systems

Next generation emergency systems are much more than just a "phone" system; their functionality, connectivity, and access options continue to evolve as new technologies emerge. IP-based ECS systems are typically designed to integrate the cross-communication of messages between a variety of communication technologies, forming a unified communication system intended to optimize communications during emergencies. In addition, because of they are natively driven by IP standards, they can deliver several communication modes including:

- One-way

- Two-way

- Conference

- Broadcast

- Multi-cast

For example, consider an IP-based emergency notification system. Using innovative network-centric technologies, these systems leverage the power and reach of computer networks and the Internet to deliver emergency alerting capabilities far beyond existing traditional systems.

- Communicate emergency information rapidly to all connected devices

- Integrate and unify disparate existing mass notification capabilities

- Provide bi-directional communication, allowing collection of feedback from all personnel

- Achieve enterprise- level scalability and processes

This proven technology uses a unified enterprise-class platform that allows emergency managers to quickly and efficiently deliver alerts to multiple devices simultaneously, including computers, IP phones, traditional landline phones, mobile phones, pagers, land mobile radios, sirens, and public address systems and receive feedback from alert recipients confirming their status. The result is the most effective enterprise-wide mass notification capability with the best cost-to-benefit ratio. Wired solutions are more reliable in disastrous situations as shown repeatedly in such events.

Benefits of IP-Based Emergency Solutions

IP-based security systems provide significant benefits in terms of new services, deployment efficiency, and operational efficiency; for example:

- Services:
    - **Access**: remote access and control via mobile and network devices
    - **Real-time information**: status, alarms, and alerts delivered in real-time
    - **Cloud Services**: enables a variety of services delivered via the cloud
- Deployment Efficiency:
    - **Lower cost**: use Power over Ethernet (PoE) to simplify installation and reduced wiring cost
    - **Ease of Integration**: Internet and LAN standards make integration easy
    - **Scalability**: can be scaled from a single site to multiple sites and functionality
- Operational Efficiency:
    - **Lower cost**: reduced power consumption through the use of EEE and other "green" enabling standards
    - **Lower operation cost**: eliminates recurring cost of analog telephone connection
    - **Lower maintenance cost**: fewer disparate elements to maintain and monitor

IP-Based Emergency Endpoint (IEE)

Depending on the application, an emergency system may require different types of functionality; for example:

- LCD to display or flash emergency messages
- Speakers to enable delivery of emergency announcements to a group
- LED indicators (to support hearing impaired)
- Power over Ethernet (PoE) for ease of installation
- Automatically indicate caller's location

At the core of these new emergency system is an IP-based emergency endpoint (IEE). These endpoints form the basis of a variety of ECS applications. Typical endpoints provide a range of interfaces which together support a rich set of functions: microphone, speaker, (some may also have handsets), push button control, LCD display, and network interfaces. In addition, they are built for use in a variety of locations, such as indoor, outdoor, and remote locations (requiring solar panels for power).

Figure 3 shows a basic emergency endpoint unit for indoor use. This fixed endpoint has a speaker, microphone, and keypad found on phones. However, as shown in Figure 3, it also has special pushbuttons and status LEDs to support its function as an emergency phone. In addition, it has network connectivity on the back panel (not shown in Figure 3).
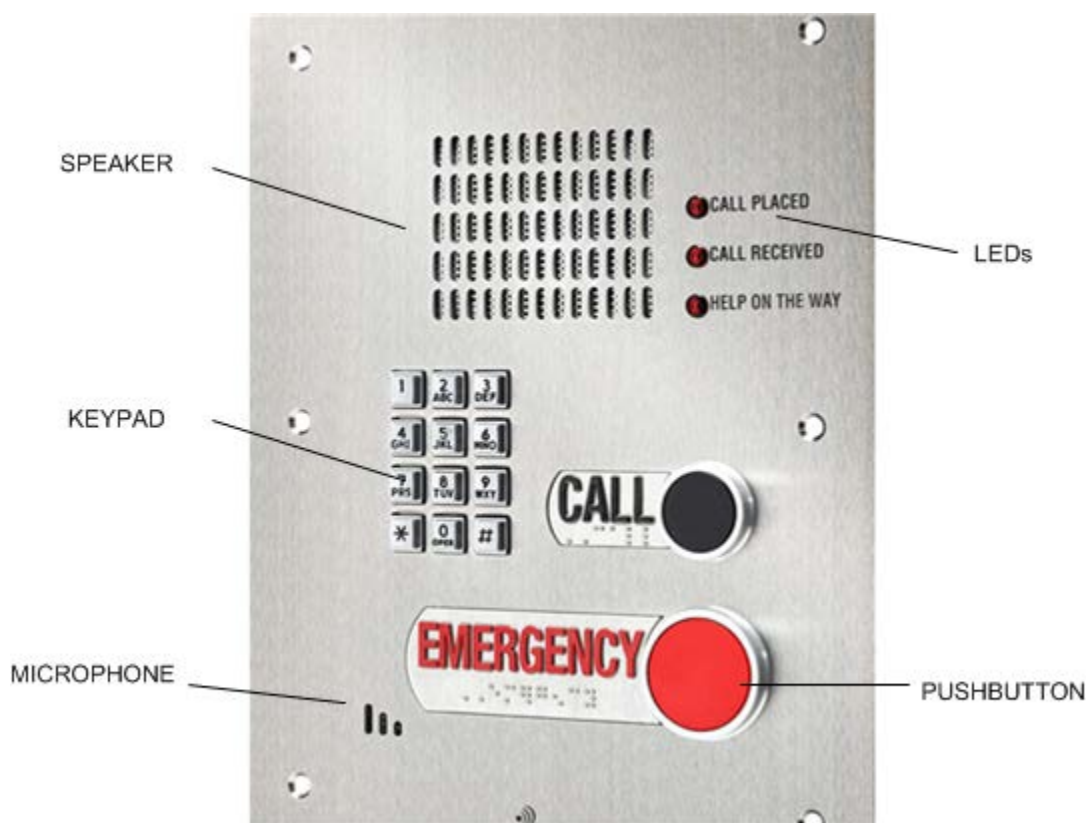

Figure 3. IP-Based Emergency Phone Endpoint

Another example of an emergency endpoint is shown in Figure 4; this endpoint focuses on both audio and visual announcements to provide emergency messages. A network interface and built in web server provides the interface to configure and control this endpoint.
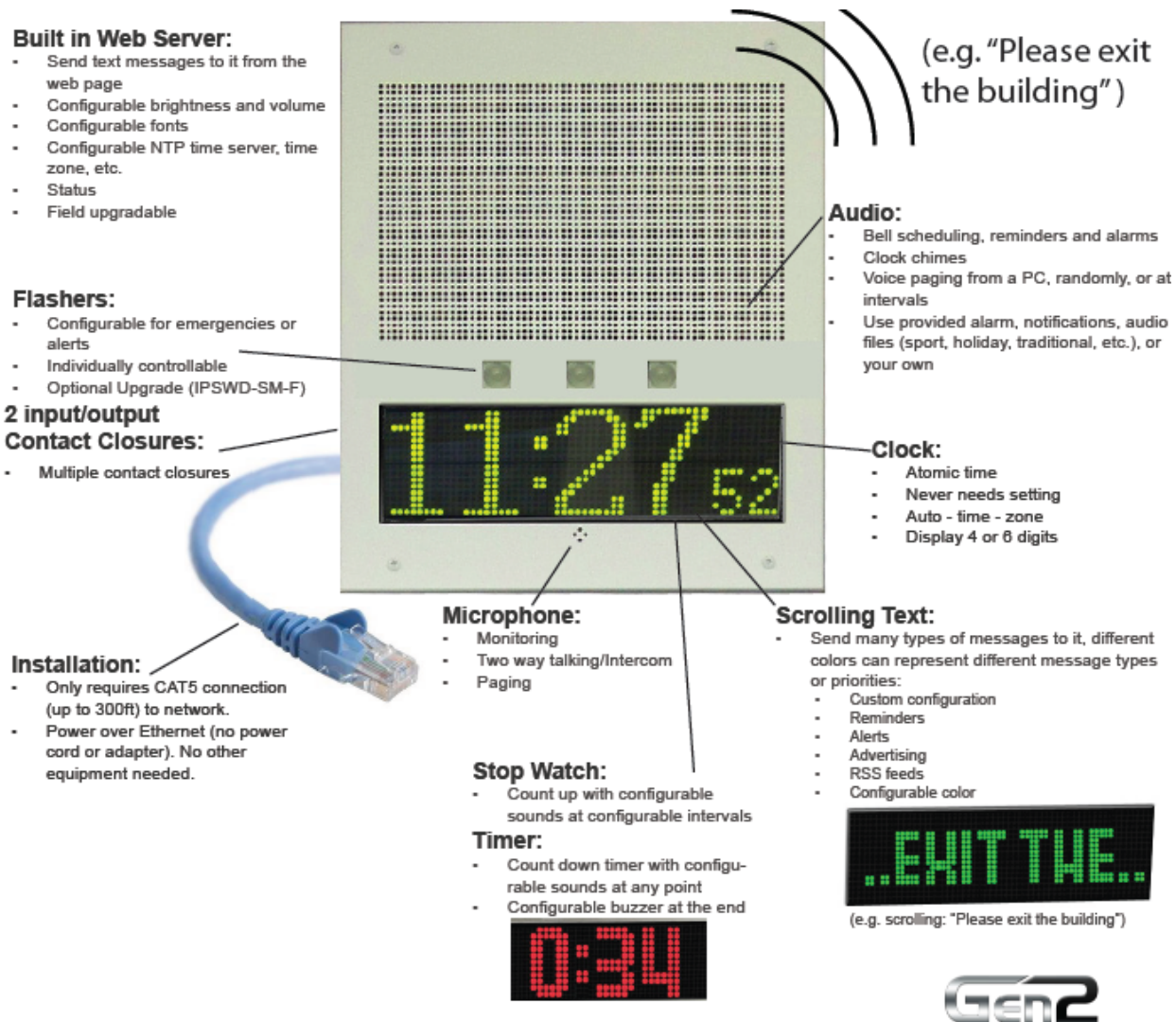

Built in Web Server:
- Send text messages to it from the web page
- Configurable brightness and volume
- Configurable fonts
- Configurable NTP time server, time zone, etc.
- Status
- Field upgradable

Flashers:
- Configurable for emergencies or alerts
- Individually controllable
- Optional Upgrade (IPSWD-SM-F)

2 input/output Contact Closures:
- Multiple contact closures

Installation:
- Only requires CAT5 connection (up to 300ft) to network.
- Power over Ethernet (no power cord or adapter). No other equipment needed.

Microphone:
- Monitoring
- Two way talking/Intercom
- Paging

Stop Watch:
- Count up with configurable sounds at configurable intervals

Timer:
- Count down timer with configurable sounds at any point
- Configurable buzzer at the end

(e.g. "Please exit the building")

Audio:
- Bell scheduling, reminders and alarms
- Clock chimes
- Voice paging from a PC, randomly, or at intervals
- Use provided alarm, notifications, audio files (sport, holiday, traditional, etc.), or your own

Clock:
- Atomic time
- Never needs setting
- Auto - time - zone
- Display 4 or 6 digits

Scrolling Text:
- Send many types of messages to it, different colors can represent different message types or priorities:
  - Custom configuration
  - Reminders
  - Alerts
  - Advertising
  - RSS feeds
  - Configurable color

(e.g. scrolling: "Please exit the building")

Figure 4. IP-Based Emergency Speaker Endpoint

Micrel's SoC-Based Emergency Endpoint

Micrel's KSZ8382 family of SoCs provides a complete solution for IEEs for a wide range of applications. The SoC has built-in support for interfaces required for an endpoint (see Figure 5); hence only a few additional external components are needed to create a fully-functional endpoint.
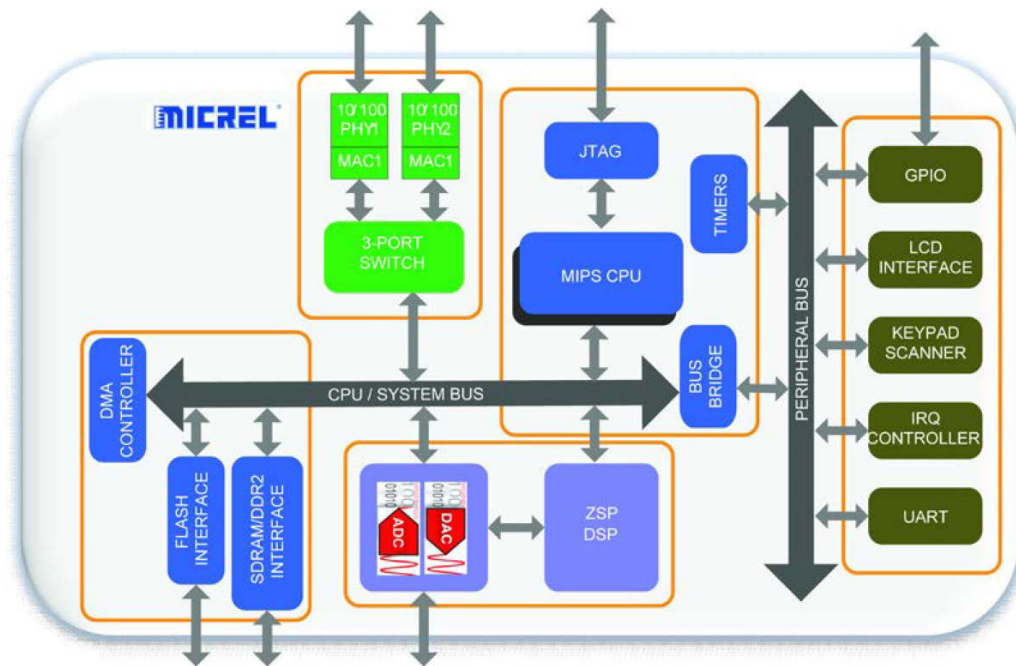

Figure 5. Block Diagram of Micrel's KSZ8382 SoC

The KSZ8382 implements a multiprocessor architecture with embedded RISC CPU and powerful DSP, providing a flexible VoIP platform with narrowband and wideband voice processing and excellent voice quality.

Embedded Processing Resources

- CPU and memory: The SoC has a MIPS32 RISC processor for configuration and network protocol processing, SDRAM and DDR2 interfaces, and Flash interface
- DSP: ZSP400 DSP offers high-quality voice/audio processing, 8kHz/16kHz 16-bit ADC/DAC with integrated amplifiers, Narrowband and Wideband CODECs

Endpoint Interfaces

- **Audio and Video**:
    - Audio support for handset, headset, and microphone and speaker
    - Video support for network-enabled cameras
- **Network**: 3-port 10/100BaseT Ethernet switch; integrated low-power PHY transceivers
    - IGMP snooping to handle multicast traffic (RFC 4541)
    - VLAN support (IEEE 802.1Q)
    - Energy Efficient Ethernet (IEEE 802.3az)
- **GPIO**: can be used for a variety of functions including LEDs and indicators
    - Keypad Scanner: can be used to support push buttons and even a full telephony keypad
    - LCD Interface: supports SPI (8-bit parallel interface)

Firmware: CPU and DSP

The firmware has a modular architecture to provide developers with a variety of choices in developing their Endpoint Applications (see Figure 6).

1. **SIP Call Control**: For a turnkey solution, developers can leverage the built-in SIP call manager from the Endpoint Application. The layers below handle media transport and DSP functionality.
2. **SIP-less Application**: For developers who have their own SIP software (or want to implement other call control protocols) can use the RTP/RTCP access for media transport. As described above, the layers below handle network and DSP functionality.
3. **Custom Media Transport Application**: For developers who want their own call control and media transport (standards-based or even proprietary) can access the DSP resources directly.

The above three options are shown in Figure 6 (access points from the application to the firmware).
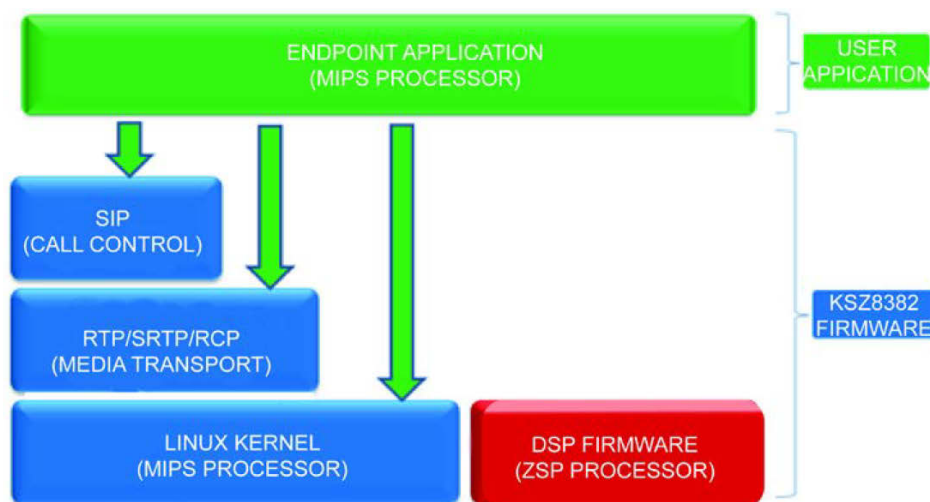
Figure 6. KSZ8382 Firmware Block Diagram

Endpoint Application Software

Using the features in Micrel's KSZ8382 SoC and the associated firmware, developers can create a variety of Endpoint Applications. These applications could support many communication modes for emergency system, including:

- **Push-To-Talk (PTT):** The network stack can be used with industry-standard protocols to create access for fast, easy voice connections.
- **Broadcast:** To call all stations for announcements and alerts.
- **Multicast:** For efficient use of network bandwidth, multicast can support group calling.
- **Private Calls:** provides the flexibility for an endpoint to be in a private call with another.
- **3-Way Conference call:** The embedded DSP provides firmware supports 3-way conference calling. The API can be used to mix audio from two network-side channels and the local audio port to create a conference bridge.

Developers can use these communication modes in any combination to create customized solutions to suit their application. The KSZ8382 SoC is the ideal choice for IP-based Emergency Endpoints, backed by Micrel's high-reliability and solution robustness proven in commercial, industrial, and automotive applications around the globe.

Conclusion

Innovation in IP-based communication systems is driving the rapid pace of migration from analog to IEEs. Micrel's KSZ8382 family of SoC devices provides a complete solution for IEEs that can be used to add cloud services to current Analog platforms or to build a completely new IP/VoIP-based application. The KSZ8382 has a high level of integration through the integration of a 3-port switch, PHY and amplifier. It has built-in support for interfaces required for an endpoint; hence only a few additional external components are needed to create a full-featured endpoint. The firmware for KSZ8382 has a modular architecture to enable developers many choices in developing endpoint applications. Together, the KSZ8382 processor and associate firmware can be used to create a wide range of IP-based solutions.