M2M Circuits Inc. has developed a self contained LTE modem. Using this modem, anything from a server down to a microcontroller can be registered on an LTE cellular network, providing SMS and internet capabilities. As the Internet of Things becomes more and more prominent, the cost of developing is diminishing. The MakerModem represents another step towards reducing this cost. The framework we have built allows rapid development of prototypes that utilize LTE functionality across a broad range of platforms, enabling hobbyists and professionals alike to quickly implement and test their ideas.

Our project involved building a library that allows other developers to easily use the modem’s capabilities without having to learn the low level details. Additionally, the library has to be able to run on a wide variety of platforms. Due to the wide variety of platforms, we had to design the library to run on the smallest microcontroller, making some sacrifices in processing speed in order to be as memory efficient as possible.

The library provides a number of functions to easily set up and being developing with the modem within a matter of minutes. The library is written to be memory efficient in order to work with small microcontrollers. It also provides low-level module access for adventurous developers and future development.

**User Interface**
- Written in C for portability.
- SWIG interface for language interoperability.

**Core Library**
- Includes functions to get the phone number, IMEI and other device information.
- Configures the module.
- Completely open-source to foster future development.

**Optional Subsystems**
- Set of methods associated with some functionality (i.e. SMS).
- Option to exclude unused features to allows for smaller binary size on embedded systems.

**Module Stream**
- Communication with the module abstracted behind a platform specific layer.
- Allows for easy porting to other systems.
- Allows direct access to Module for low-level development.

**TCP/UDP Support**
- Allows easy access to setting up TCP connections and sending UDP packets.
- Provides support for video streaming and other high data rate connections.

Our project's impact is on empowering the MakerSpace by providing an open-source, accessible library for the MakerModem. The MakerModem allows developers on wide range of platforms easy and affordable access to the Verizon LTE 4G network. This allows for rapid development of new systems utilizing the cellular network like never before.

The library is written to be memory efficient in order to work with small microcontrollers. It also provides low-level module access for adventurous developers and future development.

**Machine to Machine**
- Multiple devices networked together.
- Allows rapid prototyping of Internet of Things devices.

**Remote Monitoring**
- Not constrained by location.
- Farms.
- Oil fields.
- Video streaming possible with 4G connectivity.

**Command and Control**
- SMS and web based interfaces enable control of devices from virtually anywhere.

During the semester, our team worked with a team of Electrical and Computer Engineers to develop some additional requirements for the library. This team will be using our library to develop a drone which can be remotely flown.

All of our work will be released as open source so that the community may continue to improve and support more platforms.

Our library had a few shortcomings. In order to maintain portability, we had to trade memory for speed in a few sections. Additionally, we were unable to support incoming connections. We are unsure if this is a fault on our part, or a limitation of the network.

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