CRL Sweden

COMMUNICATION RESEARCH LABS SWEDEN AB
Communication through innovation®

microC-CORE

OEM Mesh software designed for easy adaptation. Complete OS and drivers for Mesh communication in **micro radios** *and sensor networks. Provides auto configurable and extremely* **low power** *consumption radio networks significantly reducing cabling.*

Wireless Sensor Network Mesh technology for

High demanding applications requiring Performance and Robustness

» **Industrial Automation & Communication**

» **Military & Tactical network**

» **Security & Surveillance**

» **Homeland Security & Public Safety**

FEATURES

- » **Self healing** and **auto configured** radio network infrastructure
- » **Substantially less need for cabling** with a Meshed infrastructure
- » Network size from **in-house to city wide**
- » Designed for **rapid porting to any micro sized radio platform**
- » Radio platform agnostic, e.g. 270MHz, 433MHz, 868MHz, 915MHz, 2.4GHz, etc
- » **Extremely small footprint**, typically less than 50 kB of ROM (including application) / 8 kB of RAM
- » **Extremely low power consumption**, up to **6 years** running on AA batteries

## CUSTOM-MADE OEM MESH ROUTING SOFTWARE - *What does this really mean?*

Communication Research Labs Sweden AB provides technical development and integration services for Mesh technology. Additionally technical support for implementation and integration of wireless mesh communication.

To make it custom-made we help you to integrate the wireless technology into your products or applications. Either as an OEM software component in networking equipment or integrated in customers system solution, enclosed with configuration tools and management software.

CRL delivers OEM software solutions for a variety of different radio hardware platforms, independent whether the requirements are 443, 868, 915MHz, 2.4GHz or any other radio frequency, independent if data rate is 1.2 kbps and 2 km between radio nodes, or 250 kbps of shorter range. Product companies and system integrators can combine standard radio chips and standard DSP chips, together with their own electronics, sensors and actors or using manufacturers of their own choice.

CRL's solutions are specially developed for robust and high demanding applications. We combine extremely low power consumption and high performance making µC-CORE ideal for use in industrial automation and communication, military and tactical networks, security and surveillance.

µC-CORE can turn low power radios into IP-enabled links providing efficient interoperability between low-power devices and existing IP devices, thus paving the way for further standardization of communications. This innovative technology makes embedded devices a part of the Internet and provides uncontested advantages for chip manufacturers, OEMs, system integrators and solution providers.

50 - 2000 m
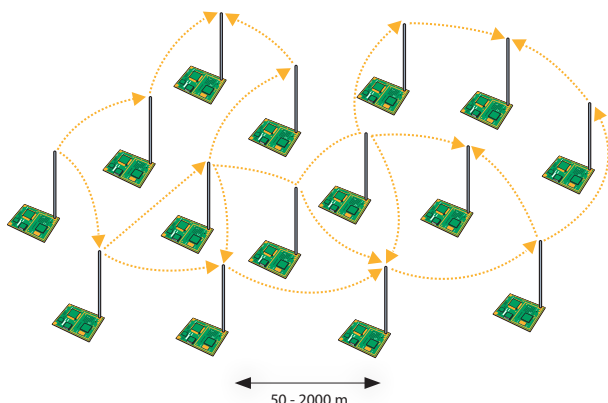
MESH CHANGES INFRASTRUCTURE FOREVER

By OEM partnership with CRL, the product companies and system integrators can combine standard radio chips and standard DSP chips, together with their own electronics, sensors and actors, using manufacturers or partners of their own choice.

Features of a µC-CORE enabled network

Mesh enabled communication

Each node in the network establishes the optimal path to its closest neighbor in order to reach a specific destination. Links between nodes are constantly evaluated and the network self-tunes to maintain performance, fully automatic and without need of human intervention. This might occur if for instance a node is added or removed from the network.

Micro in size and power consumption

A key attribute to achieving extremely low power consumption in a radio system is the radio software. As the power consumption ratio between a radio transmitting compared to an idle radio platform can be as high as 4.000 it is essential to have a software that optimizes the transmission. Optimization is accomplished through advanced time synchronization between nodes and requires a very high interaction between the MAC layer protocol, Mesh/Routing layer protocol and the application sending/receiving. This is when µC-CORE becomes the key.

The µC-CORE mesh framework is designed for low-power and long lasting operations. During normal network operation the CPU is in sleep mode about 99% of the time with power consumption less than 7 µA for a high quality low power radio module.

Low-power mode listening with time synchronization between units enables the radio to be turned off more than 90% of the time depending on baud rate and duty/sleep cycle configuration.
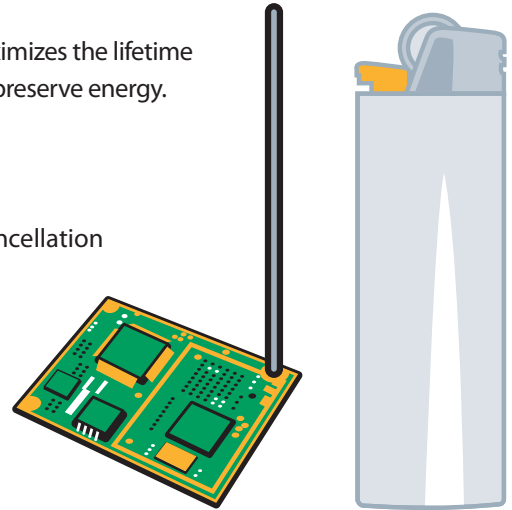
Low Power Mode (LPM)

Low data rate communication minimizes the power consumption and to maximizes the lifetime of the unit. Duty cycle operation can be set to 200 ms or 1500 ms in order to preserve energy.

High Throughput Mode (HTM)

High data rate communication to maximize data throughput with LPM cancellation temporarily disables the LPM duty cycle operation.

Interchangeable Transfer Mode (ITM)

This unique and highly innovative mode will allow the radio to automatically switch between HTM and LPM by changing the Media Access Control (MAC) protocol during operation.
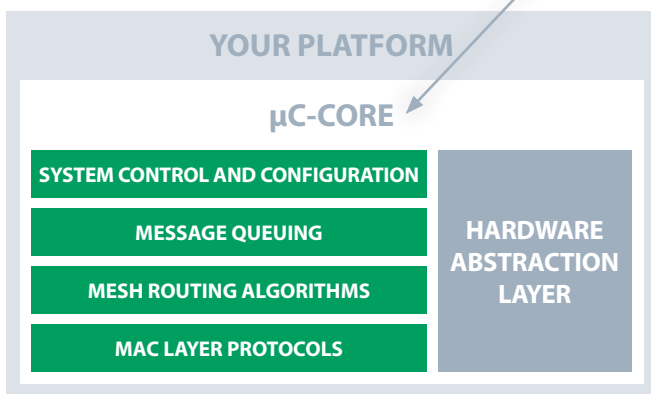
If a node need to send a large amount of data (e.g. an image from a camera) through a low power mode enabled network it will indicate this by notifying the nodes on the route to change to HTM mode. The nodes will then switch to a higher data rate and higher radio output power creating a "highway" through the network. To stay energy efficient only those nodes taking part in this transfer will change to HTM.

When data has been transferred the source node radio will tell the participating nodes to switch back to LPM mode. This creates a perfect balance between saving energy and resources in the network, and having the possibilities to boost performance when needed.

**THE TECHNOLOGY BEHIND THE SOLUTIONS; THE MESH SOFTWARE FRAMEWORK**

Hardware Interface (e.g. RS232, SPI, Ethernet) using proprietary and/or standardized communication protocol such as CRL RCP, Modbus, XML.

YOUR PLATFORM

µC-CORE

SYSTEM CONTROL AND CONFIGURATION

MESSAGE QUEUING

MESH ROUTING ALGORITHMS

MAC LAYER PROTOCOLS

HARDWARE ABSTRACTION LAYER

The software framework developed by CRL has a unique modular design making it possible to easily adapt the mesh implementation to varied platforms, ad hoc routing algorithms and services. The algorithms that handle the ad hoc routing/ Mesh protocol) in the mesh are all encapsulated in modules with sophisticated and dynamic interfaces that can be exchanged as plug-ins to the framework.

All other functionality such as memory allocations, routing tables, QoS, security, encryption and hardware are all encapsulated in separate modules completely separated from the networking logic and mesh/ad hoc algorithms. This ensures faster customization and a more robust system, where each module in the framework is thoroughly stress tested and validated through an extensive period of time.

## µC-CORE - TCP/IP COMMUNICATION: VIRTUAL ETHERNET ADAPTER
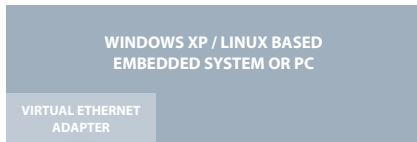
The Virtual Ethernet Adapter is a kernel mode driver developed for both Windows XP™ and Linux 2.6 operating systems which provides pure TCP/IP communication over a radio which does not support IP communication.

Interaction with the radio device can make use of either the CRL communication protocol for the µC-CORE or be adapted to use customer specific protocols.

µC-CORE - TCP/IP COMMUNICATION: TCP/IP PROXY
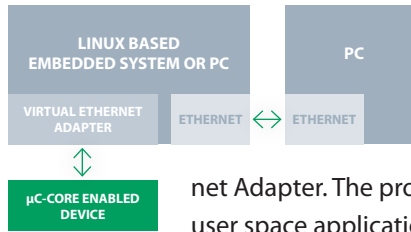
The TCP/IP proxy is developed as an alternative to the Virtual Ethernet Adapter. The proxy is developed as a user space application, with kernel space interaction, which intercepts TCP/IP sessions and creates transparent TCP/IP tunnels allowing TCP/IP communication over a none-IP radio.

The proxy software is intended for existing applications/ systems solutions where the source and/or destination of the communication path cannot be altered. Interaction with the radio device can make use of either the CRL communication protocol for the µC-CORE or be adapted to use customer specific protocols

FEATURES

» Power preservative software and hardware design
» Mesh enabled communication
» Low memory footprint (< 50kB)
» Highly configurable through serial interface
» Supports for large scale networks
» Designed to be portable to different hardware architectures

MESH CHARACTERISTICS

» Self healing and auto configured network infrastructure
» A versatile mesh network routing software
» Designed for efficient custom-made optimizations
» Cost-effective through fast adjustments for various hardware platforms
» Minimal traffic/routing overhead
» Packet queuing for in-/outbound data traffic
» Customizable
» QoS, packet fragmentation and traffic control
» Distance Vector-based mesh routing

MEDIA ACCESS

» Low-power mode listening
» Time synchronization to enable radio sleep/duty cycles for energy preservation
» Flexible, customizable and changeable at runtime
» Link-layer feedback for upper layers, e.g. signal strength to the mesh algorithm
» Reliable data transmissions (CSMA/CA, RTS/CTS, with configurable amount of retransmissions and CRC validation at reception)
» Asynchronous MAC layer protocol with minimal overhead traffic

A TYPICAL HW PLATFORM ARCHITECTURE

» 4-8 MHz MSP430-based architecture
» 5-10 kB RAM
» 48 kB programmable application flash
» External flash memory
» GPIO available for peripheral devices
» CPU sleep cycles for energy preservation
» small design: ~30x40 mm

TYPICAL WIRELESS CHARACTERISTICS

» Frequency: 180 MHz – 2.5 GHz, Currently available for 433MHz, 868-870MHz, 915MHz devices
» Low-Power, High Link Budget Integrated UHF Transceiver
» Continuous phase 2-level FSK modulation
» **High Rx sensitivity:**
   @ 1.2 kbps   -121 dBm
   @ 76.8 kbps   -104 dBm
   @ 152.3 kbps   -101 dBm
» RF output power: 0 to +12 dBm (extreme highpower + 27dBm available)
» Supported data rates include: 1200 bps, 2400 bps, 4800 bps, 9600 bps, 19200 bps, and 76800 bps
» Narrow band operation: 25 kHz channels for data rates up to 4.8

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