Introduction

There are multiple communication systems currently available, each with numerous tradeoffs in terms of cost, range, data rate, capacity, security, latency, etc. Modern cellular systems are perhaps the most versatile but also the most expensive in terms of airtime costs. Since using cellular for such applications as supporting millions of meters is cost prohibitive, many utilities have constructed various types of custom and private networks.

This Whitepaper describes Origo's proposed wide area star topology wireless network whose design goal is to create a low cost network using a single architecture that will simultaneously support both millions of low data nodes and thousands of high data nodes.

This allows a single communication network to support many different types of applications, each of which might have very different message lengths, required data rates, and latency requirements.

Network Architecture

The Origo network architecture is illustrated on page 1 of the appendix. A Central Access Point (CAP) is situated at a location with a good line-of-sight view of the area requiring communications. Typically, the CAP would be placed on a high hill, building, or tower.

The network is designed to communicate with non-mobile geographical fixed nodes throughout the service area. All communications between the CAP and the nodes is via Direct Sequence Spread Spectrum (DSSS). All nodes contain a low cost GPS module which provides frequency and time synchronization across the network.

Nodes can have very different data rates. For example, some nodes may be for low rate meter data. Other nodes may be for high rate security snapshots. A node can also function as a repeater near a data source such as a residential meter which is not in view of the CAP or for a mobile vehicle passing by a node. Numerous low cost nodes with sensors can be placed on conductors and equipment throughout the service region to monitor voltage, current, phase, and faults.

Key Features

Key features of the network are indicated on page 2 of the appendix. Since the CAP and node locations are fix and synchronized, no data collisions occur as users are added. This solves the problems of how to handle data collisions, how nodes acquire and maintain system timing, and how the network maintains performance as additional users are added. These are some of the biggest challenges of most networks but are eliminated by design in this proposed network.

Pseudo Orthogonal QPSK modulation allows the high order modulation, illustrated on pages 3 and 4 of the appendix, which conserves power and bandwidth.

Multiple access is based on signal propagation time between the CAP and nodes which allows nodes at different ranges to use the same direct sequence code.

Near perfect security using permanent firmware encryption in each node can be provided.

Performance

Network performance is summarized on page 5 of the appendix illustrating examples of various data rates the network can support.

The table gives examples of the number of multiple access users and the data rate per user available in each 1 second time slot. The graph illustrates the path loss margin, in excess of line-of-sight path loss, for ranges between 1 and 50 miles. This margin can be used to overcome actual path loss and any interference present.

Data rates per node for this example can be selected between 360 bps and 3 Mbps. Network capacity in terms of node-messages per day is greater than 15 million 256 byte messages plus 11 thousand 370 Kbyte messages. Capacity can be increased using wider bandwidths and additional frequency channels.

Summary

One of the greatest advantages of this proposed network is it's simple protocol. Each node behaves as though it were a simple point-to-point DSSS radio link with the CAP. The protocol is part of the architecture and assigned to each node by the CAP. Complex acquisition, synchronization, and retransmission protocols are not required by either the node or CAP. Network performance does not degrade as the network approaches capacity as additional users are added.

In summary, the key advantages of this communication network over other networks is its ability to be easily configured to support a large number of users with differing communication requirements while avoiding the collision, acquisition, synchronization, and retransmission problems that plague other systems designed for similar applications.

I encourage potential users to compare the capabilities of this low cost network with other complex protocol systems. This proposed network can start off small and its capability expanded by orders of magnitude simply by adding resources to the original architecture.

Further Information

A brochure is available at http://www.origocorp.com/Files/Origo_Wireless_Network.pdf

A copy of the patent is available at http://www.origocorp.com/Patents/US8717963.pdf

Copies of the Pseudo Orthogonal QPSK modulation patents are available at

http://www.origocorp.com/Patents/US8098773.pdf

http://www.origocorp.com/Patents/US8437431.pdf

Contact

Please call or email any questions, interests, or comments you may have. Thanks.

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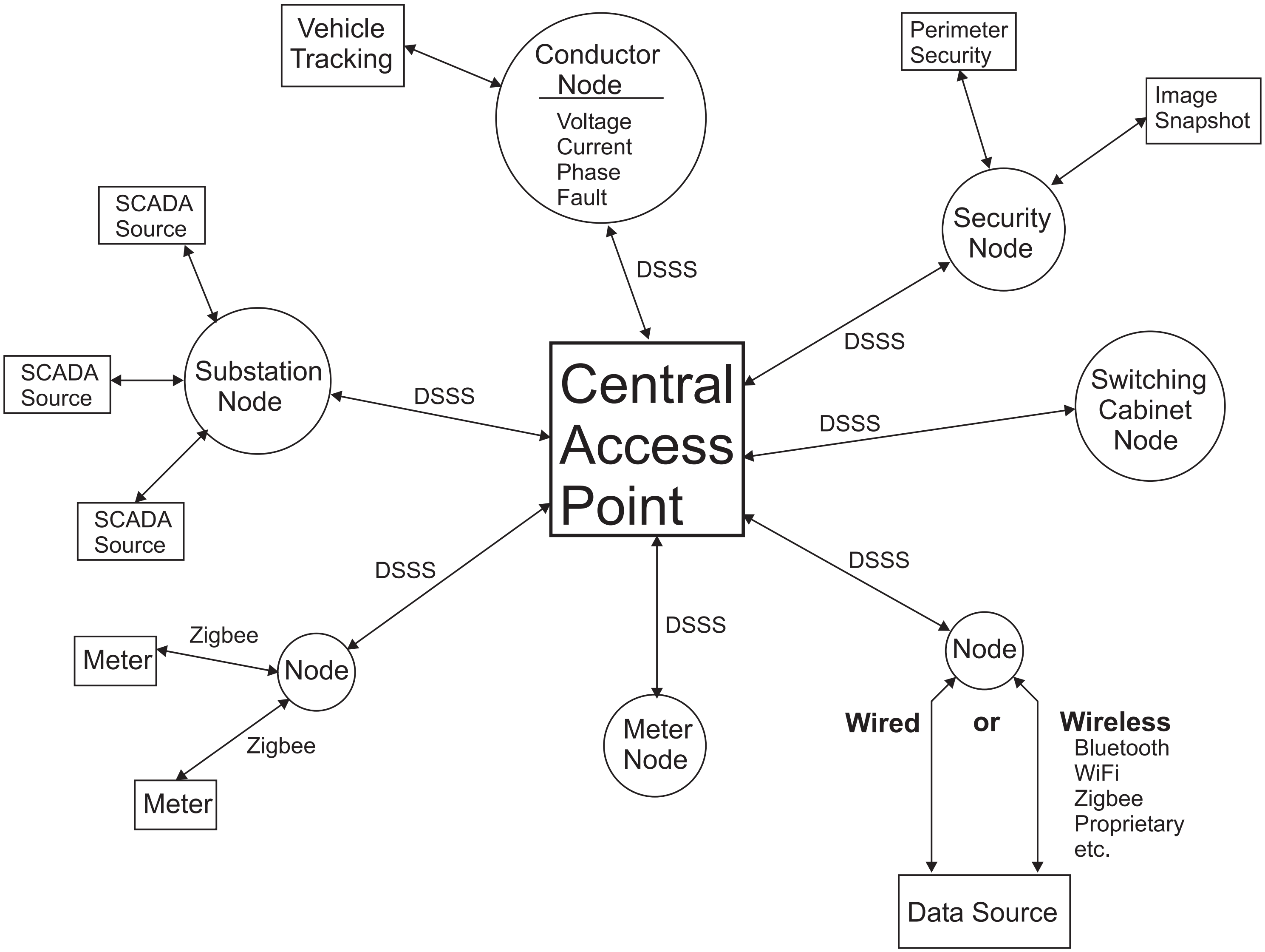
Appendix follows

Star Topology Wireless Communication Network



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Key Innovative Features

- Static Nodes with synchronized frequency and time slots.
  - No Doppler shift.
  - No data collisions.
- Direct Sequence Spread Spectrum (DSSS) packet data.
  - Direct Access Point to Node communications.
  - Simple Protocol.
- M-QAM Pseudo Orthogonal QPSK modulation.
  - Superior bandwidth and coding efficiency.
  - Low BER at low SNR.
- M-Sequence multiple access.
  - Thumb-tack auto-correlation function.
- Permanent firmware encryption in each Node.
  - Clear text address offset selects key in Node firmware memory.
- Programmable Node data rate, message rate, and sensitivity.
  - Supports a wide range of communication applications by selecting different message sizes and data rates for each application.

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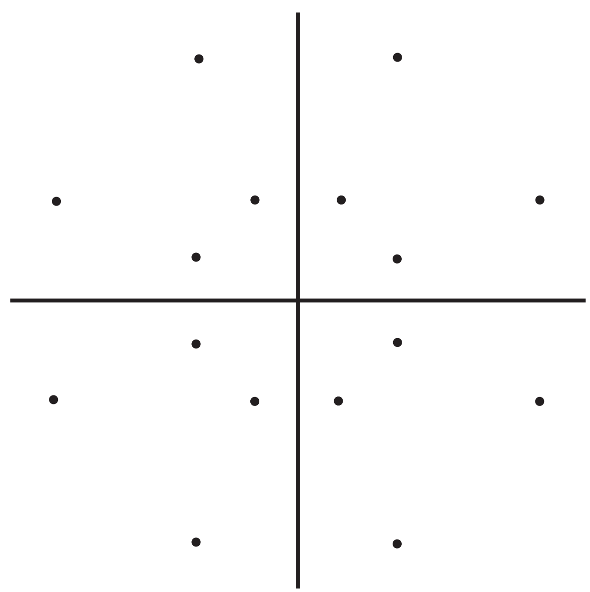
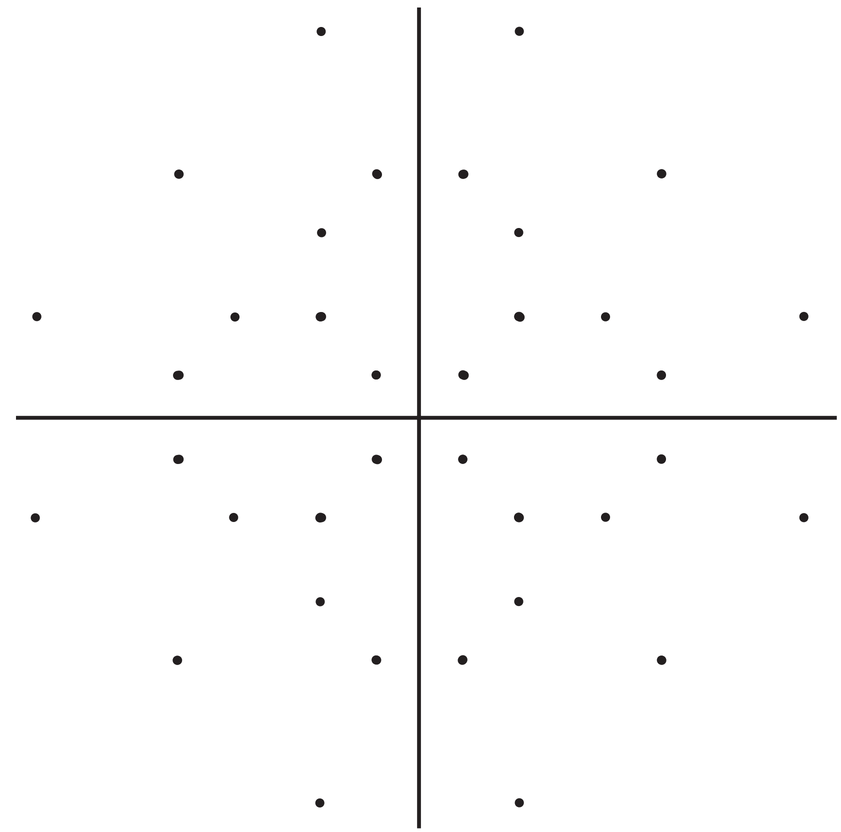
16-QAM Constellation
(16 physical symbols)



64-QAM Constellation
(36 physical symbols)



Pseudo Orthogonal QPSK (Rate 1/2 Viterbi Coding)

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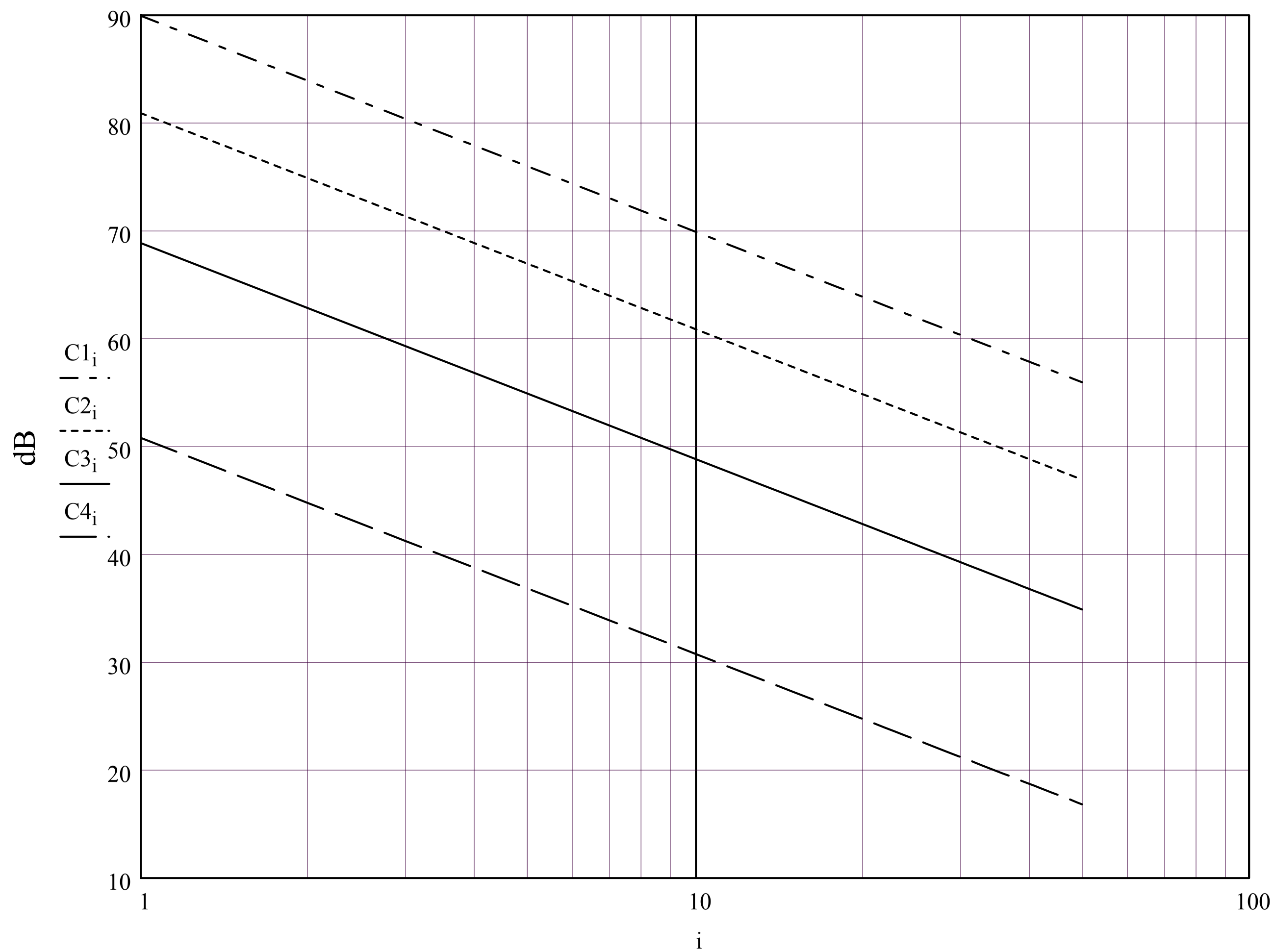
M-QAM Modulation Bits per Symbol

Modulation	Bits per Symbol: No Coding	Bits per Symbol: Rate 1/2 Coding	Relative Data Rate
BPSK	1	1/2	1X
QPSK	2	1	2X
8-PSK	3		
16-QAM	4	2	4X
32-QAM	5		
64-QAM	6	3	6X

Path Loss Margin



Range (miles)

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PLM Curve	PN Spread	User per Code	Data Rate (bps)	Data Rate (Bps)
C1	8192	2048	360	45
C2	1024	256	2880	360
C3	64	16	46k	5760
C4	0	1	3M	369k

System Parameters

2.4 GHz band
single channel frequency
1 MHz DSSS chip rate
64-QAM Pseudo Orthogonal QPSK
1 second time slots