Border Guarantee Using WINS

[1]M. Niranjala and [2]D.Mohana,
[1,2]Department of ECE, Thangavelu Engineering College (TN), India

Abstract: Wireless Integrated Network Sensors (WINS) now provide a new monitoring and control capability for monitoring the **borders** of the country. Using this concept we can easily identify a stranger or some terrorists entering the border. The border area is divided into number of nodes. Each node is in contact with each other and with the main node. The noise produced by the foot-steps of the stranger are collected using the sensor. This sensed signal is then converted into power spectral density and the compared with reference value of our convenience. Accordingly the compared value is processed using a microprocessor, which sends appropriate signals to the main node. Thus the stranger is identified at the main node. A series of interface, signal processing, and communication systems have been implemented in micro power CMOS circuits. A micro power spectrum analyzer has been developed to enable low power operation of the entire WINS system.

Thus WINS require a Microwatt of power. But it is very cheaper when compared to other security systems such as RADAR under use. It is even used for short distance communication less than 1 Km. It produces a less amount of delay. Hence it is reasonably faster. On a global scale, WINS will permit monitoring of land, water, and air resources for environmental monitoring. On a national scale, transportation systems, and borders will be monitored for efficiency, safety, and security.

I. INTRODUCTION

Wireless Integrated Network Sensors (WINS) combine sensing, signal processing, decision capability, and wireless networking capability in a compact, low power system. Compact geometry and low cost allows WINS to be embedded and distributed at a small fraction of the cost of conventional wireline sensor and actuator systems. On a local, wide-area scale, battlefield situational awareness will provide personnel health monitoring and enhance security and efficiency. Also, on a metropolitan scale, new traffic, security, emergency, and disaster recovery services will be enabled by WINS. On a local, enterprise scale, WINS will create a manufacturing information service for cost and quality control. The opportunities for WINS depend on the development of scalable, low cost, sensor network architecture. This requires that sensor information be conveyed to the user at low bit rate with low power transceivers. Continuous sensor signal processing must be provided to enable constant monitoring of events in an environment. Distributed signal processing and decision making enable events to be identified at the remote sensor. Thus, information in the form of decisions is conveyed in short message packets. Future applications of distributed embedded processors and sensors will require massive numbers of devices. In this paper we have concentrated in the most important application, **Border Security**.

II. WINS SYSTEM ARCHITECTURE

Conventional wireless networks are supported by complex protocols that are developed for voice and data transmission for handhelds and mobile terminals. These networks are also developed to support communication over long range (up to 1km or more) with link bit rate over 100kbps. In contrast to conventional wireless networks, the WINS network must support large numbers of sensors in a local area with short range and low average bit rate communication (less than 1kbps). The network design must consider the requirement to service dense sensor distributions with an emphasis on recovering environment information. Multihop communication yields large power and scalability advantages for WINS networks. Multihop communication, therefore, provides an immediate advance in capability for the WINS narrow Bandwidth devices. However, WINS Multihop Communication networks permit large power reduction and the implementation of dense node distribution. The multihop communication has been shown in the figure 2. The figure 1 represents the general structure of the wireless integrated network sensors (WINS) arrangement.

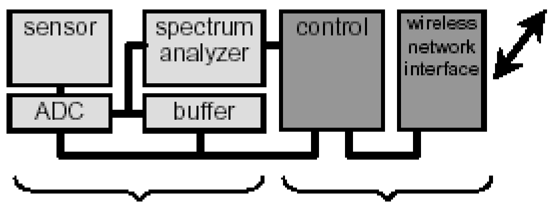

Figure 1: The wireless integrated network sensor (WINS) architecture.

III. WINS NODE ARCHITECTURE

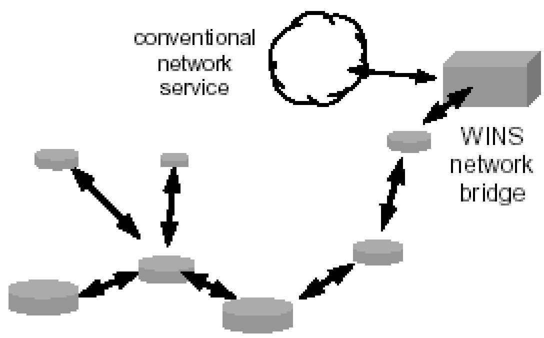

Figure 2: WINS nodes (shown as disks)

The WINS node architecture (Figure 1) is developed to enable continuous sensing, event detection, and event identification at low power. Since the event detection process must occur continuously, the sensor, data converter, data buffer, and spectrum analyzer must all operate at micro power levels. In the event that an event is detected, the spectrum analyzer output may trigger the microcontroller. The microcontroller may then issue commands for additional signal processing operations for identification of the event signal. Protocols for node operation then determine whether a remote user or neighboring WINS node should be alerted. The WINS node then supplies an attribute of the identified event, for example, the address of the event in an event look-up-table stored in all network nodes. Total average system supply currents must be less than 30A. Low power, reliable, and efficient network operation is obtained with intelligent sensor nodes that include sensor signal processing, control, and a wireless network interface. Distributed network sensor devices must continuously monitor multiple sensor systems, process sensor signals, and adapt to changing environments and user requirements, while completing decisions on measured signals.

For the particular applications of military security, the WINS sensor systems must operate at low power, sampling at low frequency and with environmental background limited sensitivity. The micro power interface circuits must sample at dc or low frequency where "1/f" noise in these CMOS interfaces is large. The micropower signal processing system must be implemented at low power and with limited word length. In particular, WINS applications are generally tolerant to latency. The WINS node event recognition may be delayed by 10 – 100 msec, or longer.

IV. WINS MICRO SENSORS

Source signals (seismic, infrared, acoustic and others) all decay in amplitude rapidly with radial distance from the source. To maximize detection range, sensor sensitivity must be optimized. In addition, due to the fundamental limits of background noise, a maximum detection range exists for any sensor. Thus, it is critical to obtain the greatest sensitivity and to develop compact sensors that may be widely distributed. Clearly, microelectro mechanical systems (MEMS) technology provides an ideal path for implementation of these highly distributed systems. The sensor-substrate "Sensorstrate" is then a platform for support of interface, signal processing, and communication circuits. Examples of WINS Micro Seismometer and infrared detector devices are shown in Figure 3. The detector shown is the thermal detector. It just captures the harmonic signals produced by the foot-steps of the stranger entering the border. These signals are then converted into their PSD values and are then compared with the reference values set by the user.

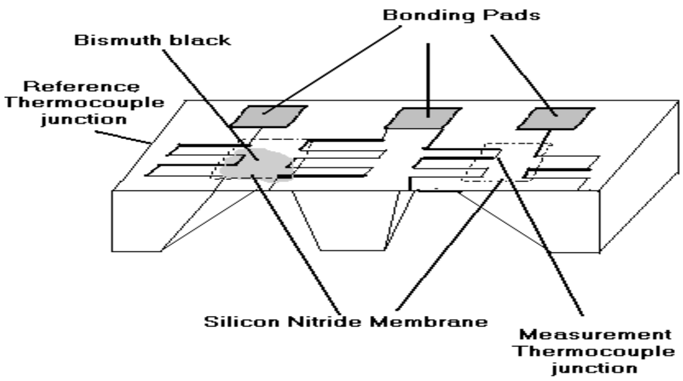

Figure 3: Thermal Infrared Detector

V. ROUTING BETWEEN NODES

The sensed signals are then routed to the major node. This routing is done based on the shortest distance. That is the distance between the nodes is not considered, but the traffic between the nodes is considered. This has been depicted in the figure 4. In the figure, the distances between the nodes and the traffic between the nodes has been clearly shown. For example, if we want to route the signal from the node 2 to node 4, the shortest distance route will be from node 2 via node 3 to node 4. But the traffic through this path is higher than the path node 2 to node 4. Whereas this path is longer in distance.

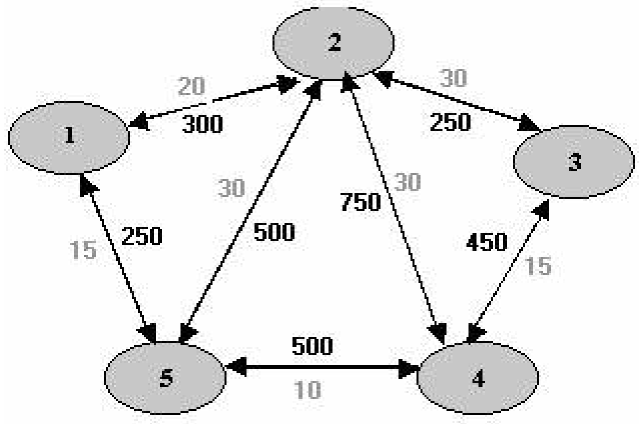

Figure 4: Nodal distance and Traffic

VI. SHORTEST DISTANCE ALGORITHM

In this process we find mean packet delay, if the capacity and average flow are known. From the mean delays on all the lines, we calculate a flow-weighted average to get mean packet delay for the whole subnet. The weights on the arcs in the figure 5 give capacities in each direction measured in kbps.

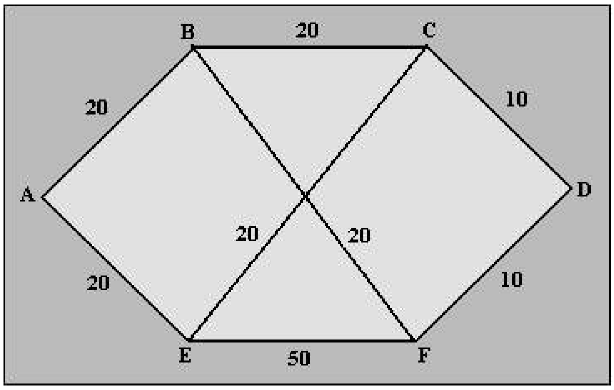

Figure 5: Subnet with line capacities

DESTINATION

SOURCE	A	B	C	D	E	F
A		9 AB	4 ABC	1 ABFD	7 AE	4 AEF
B	9 BA		8 BC	3 BFD	2 BFE	4 BF
C	4 CBA	8 CB		3 CD	3 CE	2 CEF
D	1 DFBA	3 DFB	3 DC		3 DCE	4 DF
E	7 EA	2 EFB	3 EC	3 ECD		5 EF
F	4 FEA	4 FB	2 FEC	4 FD	5 FE	

Figure 6: Routing Matrix

In fig 6 the routes and the number of packets/sec sent from source to destination are shown. For example, the E-B traffic gives 2 packets/sec to the EF line and also 2 packets/sec to the FB line. The mean delay in each line is calculated using the formula

$$T_i = 1/(\mu c - \lambda)$$

Ti = Time delay in sec
C = Capacity of the path in Bps
μ = Mean packet size in bits
λ = Mean flow in packets/sec.

The mean delay time for the entire subnet is derived from weighted sum of all the lines. There are different flows to get new average delay. But we find the path, which has the smallest mean delay-using program. Then we calculate the Waiting factor for each path. The path, which has low waiting factor, is the shortest path. The waiting factor is calculated using

$$\mathbf{W = \lambda i / \lambda}$$

λi = Mean packet flow in path

λ = Mean packet flow in subnet

The tabular column listed below gives waiting factor for each path.

i	Line	λ_i(pkts/s)	C_i(kbps)	μC_i (pkts/sec)	T_i(msec)	Weight
1	AB	14	20	25	91	0.171
2	BC	12	20	25	77	0.146
3	CD	6	10	12.5	154	0.073
4	AE	11	20	25	71	0.134
5	EF	13	50	62.5	20	0.159
6	FD	8	10	12.5	222	0.098
7	BF	10	20	25	67	0.122
8	EC	8	20	25	59	0.098

Figure 5: WINS Comparator response

VII. WINS DIGITAL SIGNAL PROCESSING

If a stranger enters the border, his foot-steps will generate harmonic signals. It can be detected as a characteristic feature in a signal power spectrum. Thus, a spectrum analyzer must be implemented in the WINS digital signal processing system. The spectrum analyzer resolves the WINS input data into a low-resolution power spectrum. Power spectral density (PSD) in each frequency "bins" is computed with adjustable band location and width. Bandwidth and position for each power spectrum bin is matched to the specific detection problem. The WINS spectrum analyzer must operate at □ W power level. So the complete WINS system, containing controller and wireless network interface components, achieves low power operation by maintaining only the micropower components in continuous operation. The WINS spectrum analyzer system, shown in Figure 7, contains a set of parallel filters.

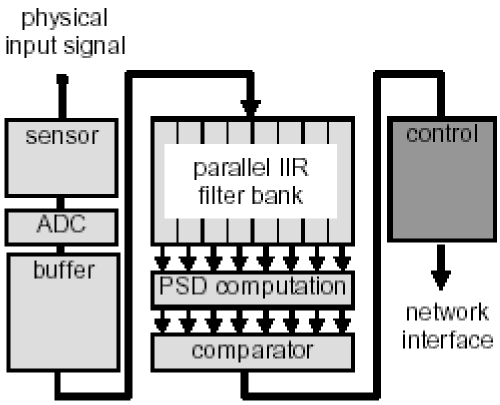

Figure 7: WINS micropower spectrum analyzer architecture.

VIII. PSD COMPARISION

Each filter is assigned a coefficient set for PSD computation. Finally, PSD values are compared with background reference values In the event that the measured PSD spectrum values exceed that of the background reference values, the operation of a microcontroller is triggered. Thus, only if an event appears, the micro controller operates. Buffered data is stored during continuous computation of the PSD spectrum. If an event is detected, the input data time series, including that acquired prior to the event, are available to the micro controller. The micro controller sends a HIGH signal, if the difference is high. It sends a LOW signal, if the difference is low. For a reference value of 25db, the comparison of the DFT signals is shown in the figure 8.

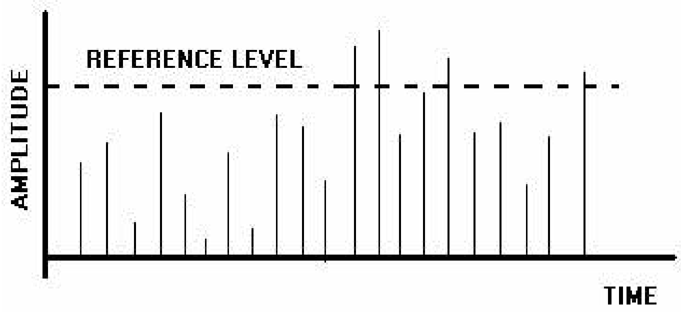

Figure 8: Comparator plot

IX. WINS MICROPOWER EMBEDDED RADIO

WINS systems present novel requirements for low cost, low power, short range, and low bit rate RF communication. Simulation and experimental verification in the field indicate that the embedded radio network must include spread spectrum signaling, channel coding, and time division multiple access (TDMA) network protocols. The operating bands for the embedded radio are most conveniently the unlicensed bands at 902-928 MHz and near 2.4 GHz. These bands provide a compromise between the power cost associated with high frequency operation and the penalty in antenna gain reduction with decreasing frequency for compact antennas. The prototype, operational, WINS networks are implemented with a self-assembling, multihop TDMA network protocol.

The WINS embedded radio development is directed to CMOS circuit technology to permit low cost fabrication along with the additional WINS components. In addition, WINS embedded radio design must address the peak current limitation of typical battery sources, of 1mA. It is critical, therefore, to develop the methods for design of micropower CMOS active elements. For LC oscillator phase noise power, S, at frequency offset of away from the carrier at frequency with an input noise power, Snoise and LC tank quality factor, Q, phase noise power is:

$$S_{\phi} \propto \frac{1}{Q^2}\left(\frac{\delta\omega}{\omega}\right)^2 S_{noise}$$

Now, phase noise power, Snoise, at the transistor input, is dominated by "1/f" noise. Input referred thermal noise, in addition, increases with decreasing drain current and power dissipation due to the resulting decrease in transistor transconductance. The tunability of micropower CMOS systems has been tested by implementation of several VCO systems to be discussed below. The embedded radio system requires narrow band operation and must exploit high Q value components.

CONCLUSION

A series of interface, signal processing, and communication systems have been implemented in micropower CMOS circuits. A micropower spectrum analyzer has been developed to enable low power operation of the entire WINS system. Thus WINS require a Microwatt of power. But it is very cheaper when compared to other security systems such as RADAR under use. It is even used for short distance communication less than 1 Km. It produces a less amount of delay. Hence it is reasonably faster. On a global scale, WINS will permit monitoring of land, water, and air resources for environmental monitoring. On a national scale, transportation systems, and borders will be monitored for efficiency, safety, and security.