

Research in *NeEWS* laboratory spans across a wide range of embedded wireless networking and system design issues including resource-constrained, self-reconfigurable and cooperative network protocols, network middleware, radio spectrum scavenging, new modes of information switching in communication networks, wearable sensing for health applications, and data storage and dissemination in social wireless networks. A few representative research projects in the *NeEWS* laboratory are summarized below.

Networked Wearable Systems for Personalized Health Management (NIH, NASA, USDA): The objective is to develop sensing, networking, and data processing mechanisms for *Connected and Personalized Healthcare* infrastructure. The concepts are to sense multi-modal physiological data using low-power wearable sensors and to develop pattern identification abstractions for monitoring health dynamics for individuals. Fig. 1 depicts a metabolic energy monitoring system developed by the *NeEWS* lab researchers. The

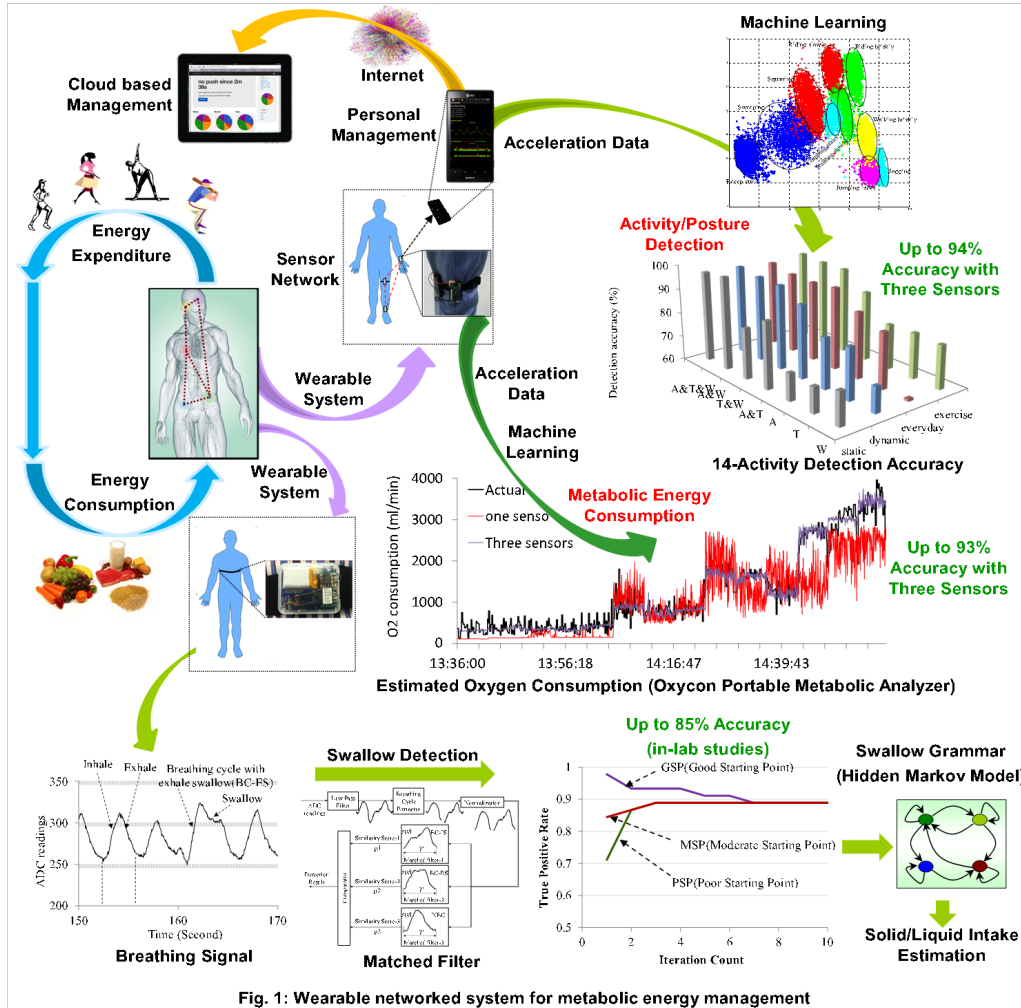


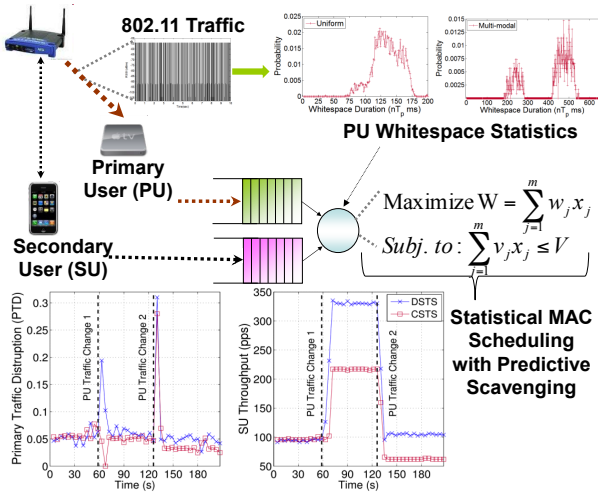
Fig. 1: Wearable networked system for metabolic energy management

classification via apnea detection in breathing signals. This project is a part of the MSU TRIFECTA initiative between the colleges of Engineering, Nursing, and Comm. Arts. A paper on this work won the best paper award in ICICS, April '12, Irbid, Jordan.

Packet-less Information Networking using Multi-hop Pulse Switching (NSF): This project investigates a novel pulse switching framework for ultra-light-weight network applications. The key idea is to abstract a single pulse, as opposed to multi-bit packets, as the information switching granularity. Pulse switching is shown to be sufficient for on-off style event monitoring applications (e.g., structural health monitoring) for which a monitored parameter can be modeled using a binary variable. *NeEWS* lab researchers have developed a joint MAC-routing architecture for pulse switching and multi-hop routing with a novel cellular localization strategy. The feasibility and performance of this system is currently being evaluated using Ultra Wide Band (UWB) and ultrasonic pulsed data links. Fig. 2 shows a prototype system using ultrasonic pulse networking for structural health monitoring of an aircraft wing. The system uses aircraft wing substrate as the communication media for reporting fault information to data loggers through a multi-hop pulse network. Key research contributions are: 1) ultrasonic and UWB pulse modulation, transmission, and detection algorithms, 2) MAC and routing layer protocols for packet-less access and forwarding of binary information, 3) cellular event localization, 4) pulse based

transport protocols for handling loss, faults, and ambient substrate noise, 5) using on-substrate event pattern recognition using spiking neural networks for implementing *cognitive substrates*. A paper on this work won the best paper award in ICWMC 2012, June 2012, Venice, Italy.

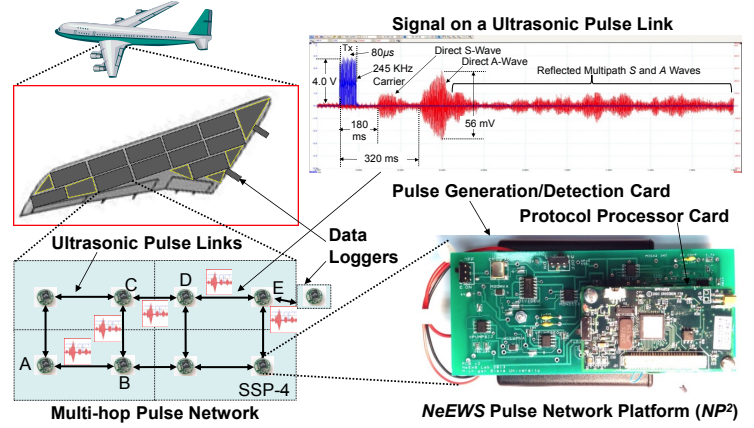
Bandwidth Scavenging in Wireless Networks (AFRL, NSF): Dynamic Spectrum Access can enable secondary network users to access unused spectrum, or whitespace, which is found between the transmissions of primary users in a wireless network. The design objectives for secondary user access strategy are to be able to “scavenge” spatio-temporally fragmented whitespace while limiting the interference caused to the primary users. In this project, we develop secondary user access strategies that are based on measurement and modeling of the whitespace as perceived by the secondary network users. A secondary user continually monitors its surrounding whitespace, models it as a stochastic process, and then attempts to access the available spectrum holes based on those models. Fig. 3



wireless network captures “physical” community formation which is complementary to the “virtual” grouping in traditional social networks such as Facebook. Computing, storage, and communication resources in such networks can often be scattered and fragmented, leading to inefficient utilization. This project explores an emerging architecture that can foster economic model based resource trading in such networks for addressing the utilization issues. Network operations based on various cost and pricing models are introduced to demonstrate how by leveraging the underlying social community abstractions, fragmented storage, computing, and communication resources can be better utilized. Fig. 4 depicts a fragmented storage trading scenario developed for reducing content provisioning costs in a Social Wireless Network. The research involves: 1) stochastic formulation of cost-reward flow among the network stakeholders, 2) developing optimal distributed cooperative trading algorithms, 3) characterizing the impacts of network, user and content dynamics, 4) investigating the impacts, and developing mechanism for controlling non-cooperation, and finally 5) investigating system performance using Android based prototype Social Wireless Networks. A paper on this work won the best paper award in IEEE COMSNETS ‘11, January 2011, Bangalore, India.

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NeEWS Lab Publications: 200+ papers, 10 patents, and 26 TRs and industry whitepapers (<http://neews.egr.msu.edu/Pub.htm>)



summarizes the bandwidth scavenging system components and their architectural relationships. Key research contributions are: 1) developing models for characterizing primary user white space and secondary user access strategies, 2) numerical evaluation of the secondary users’ throughput and primary users’ interference, 3) simulation for validating system effectiveness, and 4) developing a 900MHz prototype network for experimental validation and performance evaluation. A paper on this work won the best paper award in Globecom 2009, November 2009, Honolulu, Hawaii.

Resource Trading in Social Wireless Networks (NSF): Near-field communication among physically collocated mobile devices is becoming a popular means for content sharing and distribution in social wireless networks. Increasing market penetration of mobile devices and their support for short-range radio links are making such networks a distinct possibility in settings such as a University and other public places. A social

