Distributed Radiation Monitoring Via a Secure Wireless Sensor Platform

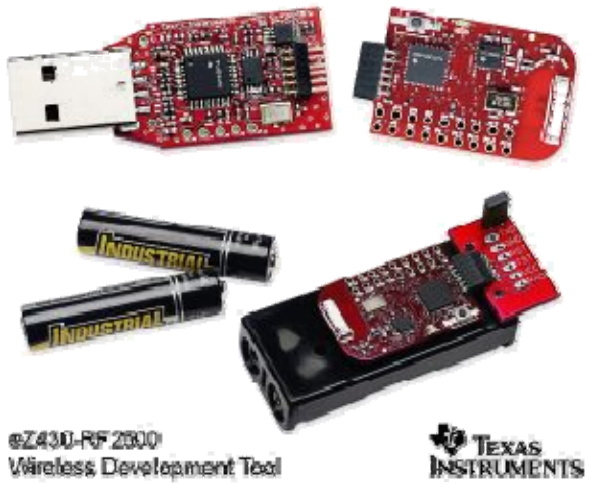
Nathan C. Rowe

University of Tennessee

Intern Oak Ridge National Laboratory

Introduction

- **New Low-Power Wireless Technologies**
  - **IEEE 802.15.4 and Zigbee**
- **Use of Sensors in Safeguards**
  - **Radiation Monitoring**
- **Item Monitoring Using Wireless Sensor Networks**



Presentation Overview

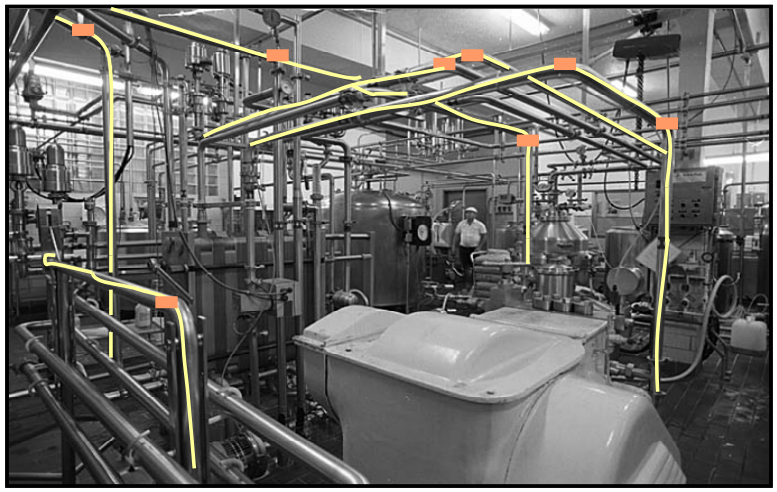
- **Application**
- **Requirements**
- **Proposed Platform**
- **Battery Life Estimation**
- **Limitations**
- **Future Work**

Advantages of Wireless

- **Easier and cheaper installation**
- **More flexible configuration**
- **Reduced need for site access**
- **Reduced human radiation exposure**

Applications of Distributed Radiation Monitoring

- **Arms Control Monitoring**
- **Storage or Vault Monitoring**
- **Process or Hold-up Monitoring**



Requirements

- **Accurate and timely data**
  - **To monitor long term background data**
  - **And short term event detection**
- **Data security and authentication**
  - **To provide confidence in the collected data**
- **Low-Cost installation and maintenance**
  - **To make the distributed monitoring cost effective**

Accurate and Timely Data

- **The goal is to provide enough data for effective monitoring while maximizing battery life**
  - **Length of each measurement**
  - **Frequency of measurements**
  - **Flexibility to setup for particular application**

Data Security and Authentication

- **The goal is to provide confidence in the collected data**
  - **Private public key encryption algorithms**
  - **Must overcome problems with implementing these in a wireless system**

Installation Cost and Maintenance

- **Lower installation cost**
- **Increased maintenance cost for battery replacement**
  - **Long battery life will reduce this cost**

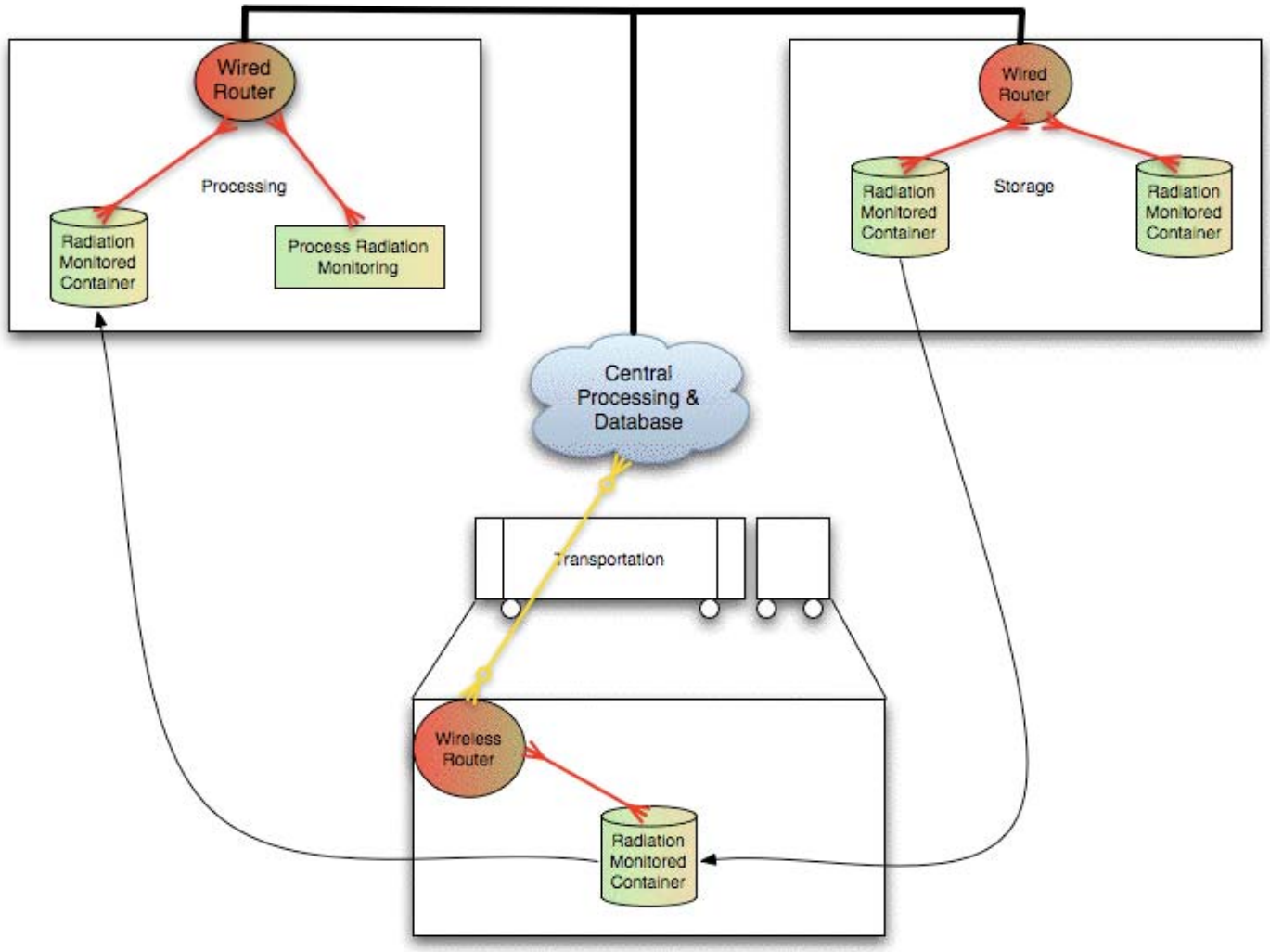
Limitations

- **Denial of sleep attack**
  - **Battery life of the device is vulnerable**
  - **Jamming used to attack battery life**
  - **Accelerometer used to attack battery life**
- **Limited usefulness as a tracking device**
  - **Low reporting frequency for power conservation**
  - **Won't recognize a sensor as missing until it fails to report**

Proposed Platform

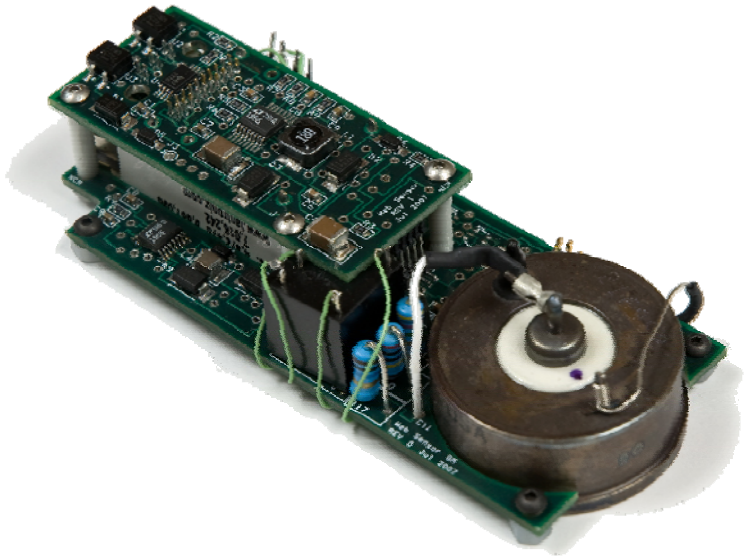
- **IEEE 802.15.4 and Zigbee**
- **Onboard AES coprocessor**
- **Flexible sensor interface**
  - **User defined sampling duration and frequency**
- **Accelerometer for movement event wakeup**
- **Geiger Mueller Sensor Package**

Network Topology



Geiger Mueller Sensor Package

- **Developed for use with both wired and wireless platforms**
- **Power efficiency is essential for battery operation**
- **Some initial testing was done, but more is needed to verify accuracy and sensitivity**



Estimated Current Consumption

Component	Current consumption (mA)	Daily on time (h)	Daily current consumption (mAh)
Sensor 500V supply, GM Tube, and Output filter	**12.6**	**0.33**	**4.2**
Accelerometer ADXL330	**0.3**	**24.00**	**7.7**
Microprocessor CY8C29466	**5.0**	**0.34**	**1.7**
Transmitter CC2420	**18.8**	**0.01**	**0.2**
		Total Daily Current Consumption (mAh)	**13.8**

Battery Life Estimates

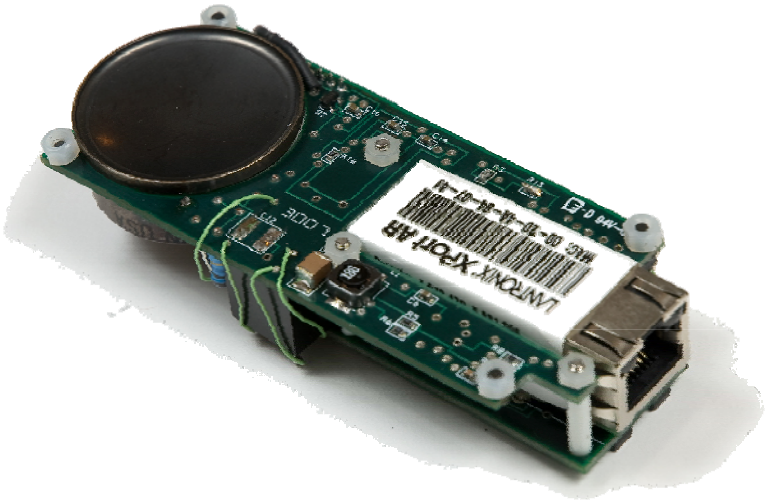
Battery	Ah (Nominal)	Battery life (years)	
		5 min. sampling duration	1 min. sampling duration
2AA	2	0.40	0.60
4AA	4	0.79	1.20
2C	8	1.59	2.40
2D	17	3.38	5.12

Future Work

- **Finish prototype wireless radiation sensor**
- **Testing of wireless sensor platform**
  - **Confirm communication range and battery life**
- **Testing of sensor package**
  - **Determine necessary sampling durations**

Conclusion

- **Wireless allows for cheaper installation and more flexibility in sensor placement and attachment**
- **Flexible data collection, secure transmissions, and long battery life are necessary features for a successful platform**



Acknowledgements

- **Chris Pickett, Oak Ridge National Laboratory**
- **Jim Younkin, Oak Ridge National Laboratory**
- **Brad Stinson, Oak Ridge National Laboratory**
- **Dr. H. Li, University of Tennessee**