Autonomous Biodetection System

A Collaborative MASINT Research Project

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Overview

- **Project Goals**
- **System Components**
- **Project Roadmap**
- **Current R&D**
- **Proposed R&D**

Autonomous Biodetection System

System Capabilities

- **Detection of Class A bioagents**
- **Airborne or water detection**
- **Small, portable**
- **Highly sensitive and specific**
- **High confidence**
- **Near real time**
- **Autonomous**
- **Low power consumption**
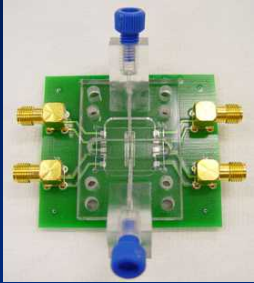- **Long-term field deployment**

Technology Requirements

- **Integrated sample prep**
- **Analyte concentration**
- **Multiple sensors**
- **Multiplex detection**
- **Robust, reliable**
- **Low consumables**
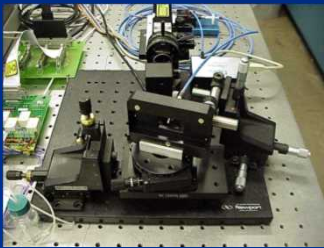- **Communications link**

Current Status

- **Sensor development underway**
- **Some individual components at TRL 2 - 4**
- **No complete solution exists**

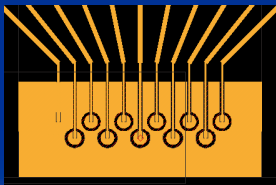# Critical System Elements

Sample Preparation Stage

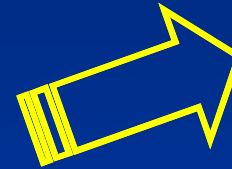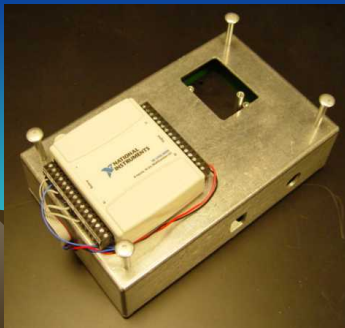*Extracts biological signature from air or water*

Trigger Sensor

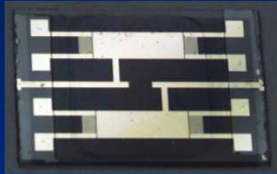*Robust, preliminary detection*

Identifier Sensor

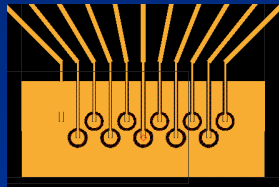*Multiplex array of highly specific, highly sensitive detectors*

System Development Roadmap
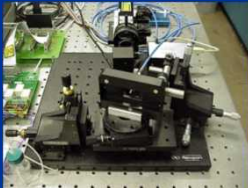
Year 1 (Current)
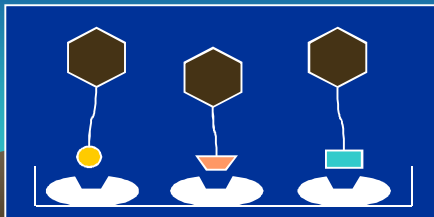### Sensor Development

SH-SAW

Electrochemical

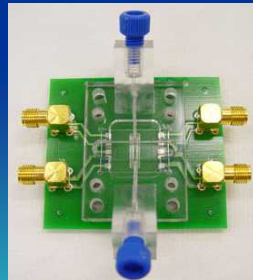**Optical**

Bio-Selective Ligands

Year 2
System Engineering

Con-Ops Evaluation

Plume Modeling

Multi-agent Detection

Sensor Downselect

Microfluidics

Sample Prep Stage

Year 3
System Integration

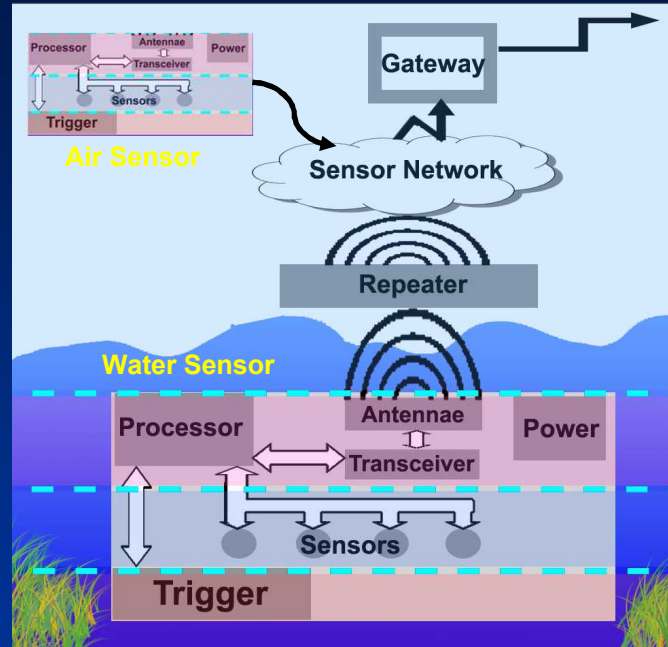Sensor Optimization

Sensor Integration

Packaging

Year 4
Multi-platform Detector

- Networks
- Wireless transmission
- Data management
- Data security

Roles and Responsibilities

- **Automated sample prep**
- **Combined trigger and identifier sensors**
- **Specific and sensitive ligands**
- **Microfluidics**

- **Wireless communication**
- **Stand-alone or network deployment**
- **Power management**
- **Data management**

UNM

Ligand Development
- **Biology expertise**
- **Bio Safety Level 3 facility**
- **Bioagent production**
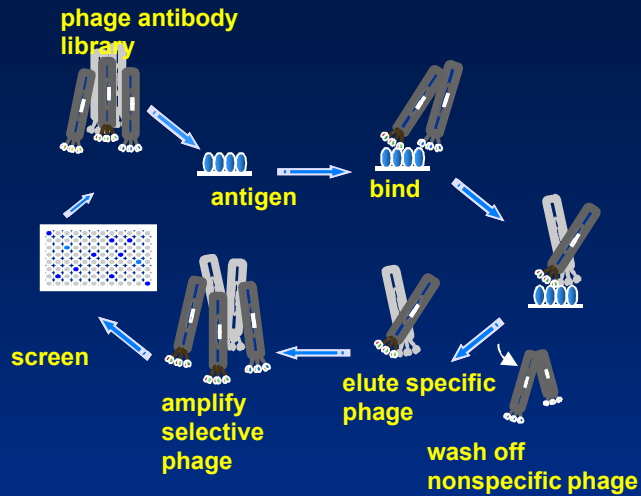- **Live agent testing**

LANL

Ligand and Sensor Development
- **Chemistry**
- **Surface functionalization**
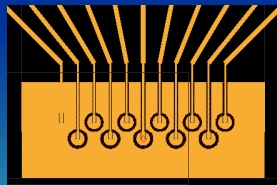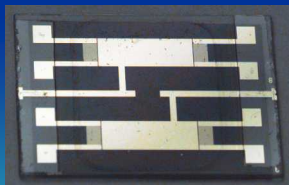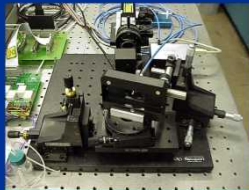- **Sample preparation and concentration**
- **Transducer research**

SN

Microsystem Development
- **Microfabrication**
- **Modeling**
- **Communications**
- **System Engineering**
- **System integration**

Current R&D Activities

phage antibody library

antigen

bind

screen

amplify selective phage

elute specific phase

wash off nonspecific phage

Selective, Sensitive Detection
Phage Display Ligand Development

Non-fouling Surfaces for Improved S/N Ratio
PEG-Terminated Long-Alkyl Chain SAMs,
Voltage-Driven Diazonium Assembly

Sensor Development
Optical Trigger, SAW and
Electrochemical Identifier
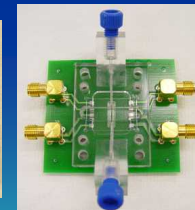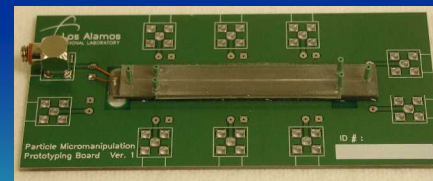
Sample Prep
Acoustic Concentration, Lysing,
Mixing, and Cleaning

Progress to an Autonomous Sensor System

Past

Original System

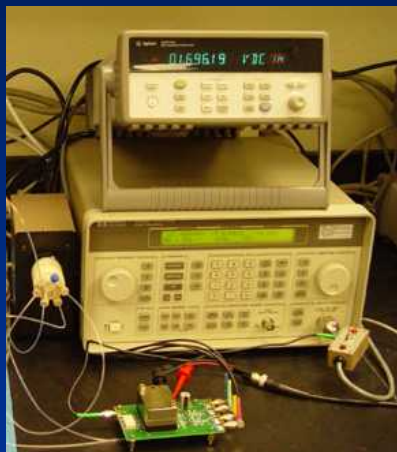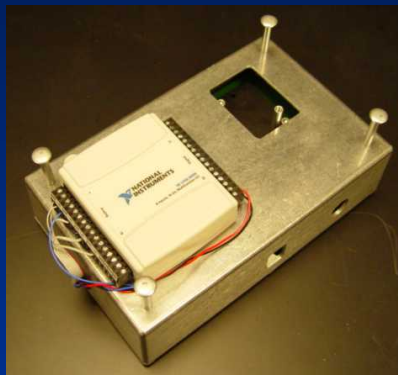- **Single SAW sensor**
- **External power supply and signal processsing**

Present

Current System

Contains:
- **3-sensor SAW array**
- **Internal RF signal processing**
- **Internal RF power supply**
- **Temperature compensation**
- **Fluidic control**
- **16 input, 8 I/O, 2 D/A USB DAQ**

Future

Autonomous Sensor Network

Will incorporate:
- **Sample collection**
- **Integrated microfluidic sample preparation**
- **Trigger and identifier sensors**
- **Battery power**
- **Communications**
- **Autonomous operation**

Proposed Deployment

We will employ an existing RF communication system developed for autonomous sensor operations.

Internetted RF Link

Local Area Network
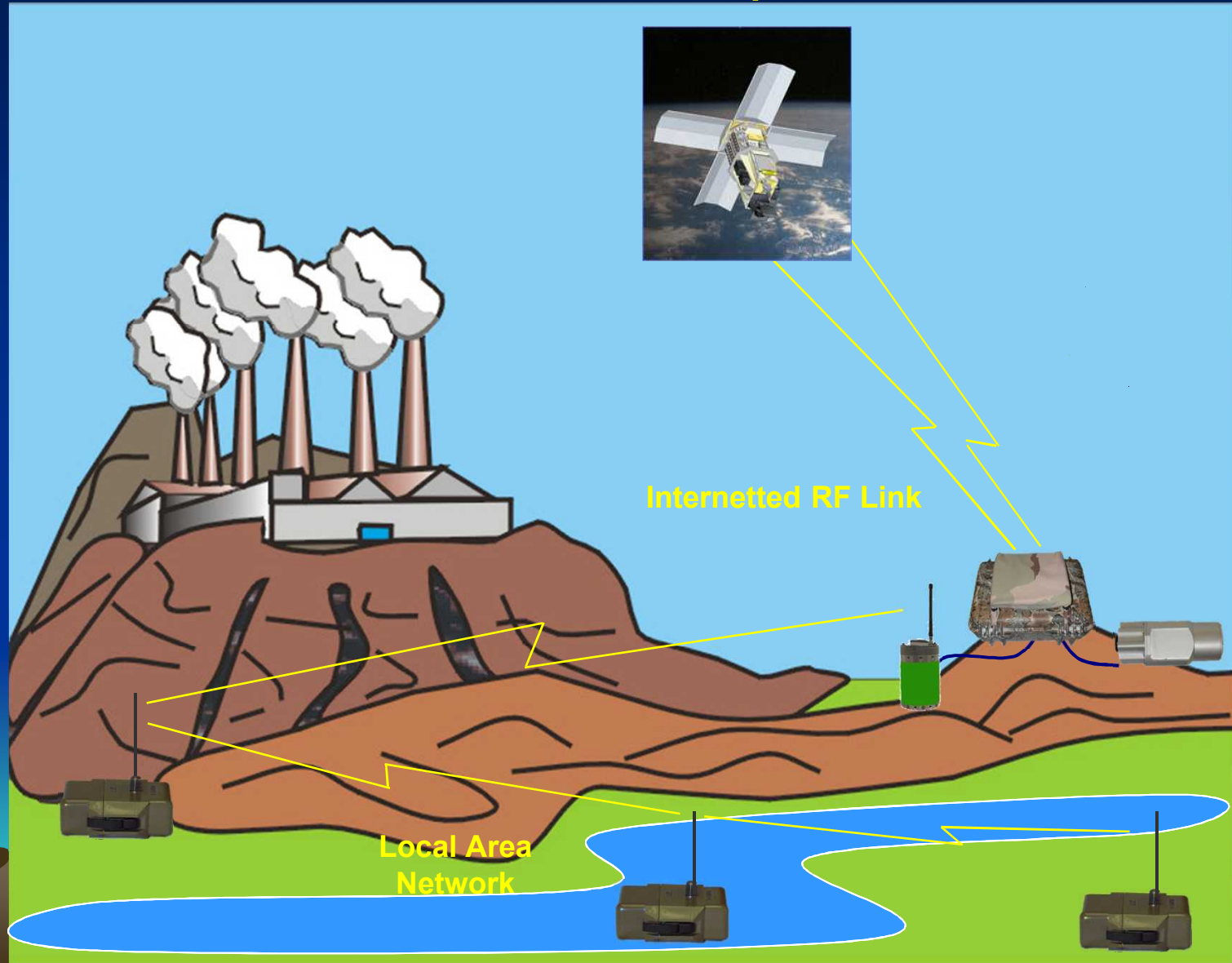
Proposed R&D

- **Con-ops evaluation with sponsor**

- **Plume modeling in air and water**

- **Autonomous sample collection and preparation**

- **Development of new ligands for additional bioagents**

- **Ligand attachment on multiplex sensor arrays**

- **Evaluate electrochemical trigger and identifier microsensors**

- **Integration of trigger and identifier sensors**

- **Integration of sample prep with sensors**

- **Fabrication and field-test a prototype system**