[TDX2]  
Future WSN Sensor Technology  
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Outline

• Overview – How Can We Build Better Sensors?
• Embedded Sensors
• A New WSN Concept
• Summary
How Can We Build Better Sensors?

• What is “better”? 
How Can We Build Better Sensors?

• Let’s focus on cost and energy:
Embedded Sensors

• Applications

• Missions

• Challenges
A New WSN Concept

Channel

Sensor Node #n

High-Q Coupled

Transceiver

n-1

n+1

Interrogator

f_o

2f_o

fo

2fo
A New WSN Concept

Interrogator/Communications

Concrete Structure

Sensor Node

- Humidity
- pH

Field Testing, Sensor/Transceiver

<table>
<thead>
<tr>
<th>node #</th>
<th>f_o (Hz)</th>
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<tr>
<td>1</td>
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A New WSN Concept
A New WSN Concept

Transmitting Setup

Receiving Antenna

FDR

1.3 GHz

2.6 GHz
A New WSN Concept

\[ k_z >> k_x & k_y \]

Slope \( \Rightarrow \) Stiffness, \( K \)

(c)

Detect single \( x \)-axis acceleration (i.e., \( a_x \))
\( a_z \) and \( a_y \) are confined

(d)

Proof mass is only allowed to move along the \( x \)-axis

A-A’ Side View

Capacitive Transducers

Proof Mass

Proof Mass

\[ C_L \uparrow \quad C_R \downarrow \quad C_o = C_L - C_R \sim 2 \Delta C \]
A New WSN Concept

Stimuli-responsive sensor $\rightarrow$ varactor to control frequency response of narrowband micromechanical multiplier

Variation of node response based on sensor state

$\frac{f_0}{2} \cdot f_0$

RX Antenna

TX Antenna

Disk Resonator

Electrode

20nm Nitride Gap

After HF 40min Release

Nitride etched away at the edge only
A New WSN Concept
Summary

• All WSN applications present challenges, and some may not be feasible with current-day technology
• Gain from optimizing individual pieces of a system eventually goes to zero → systems-centric thinking can reveal unique solutions
• In the advanced WSN concept discussed here, where will the most energy be used?