SuctionSense

Smart Suction, Sustainable Savings

Sharon Chao[1], Nathan Nguyen[1], William Hayes[2], Arjit Misra[1]

[1] Carle Illinois College of Medicine, Urbana, Illinois 61801

[2] Columbia University, Department of Mechanical Engineering, New York, New York 10027

Carle

Hospital Sisters HEALTH SYSTEM

STA Society for Technology in Anesthesia
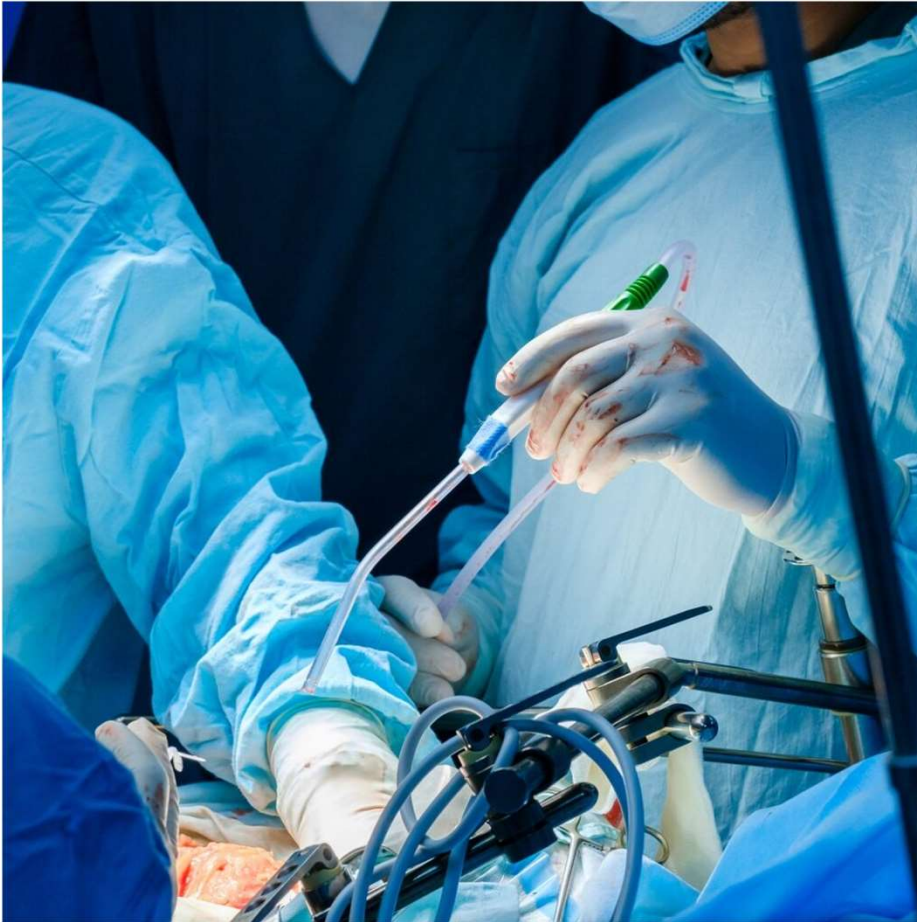
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN
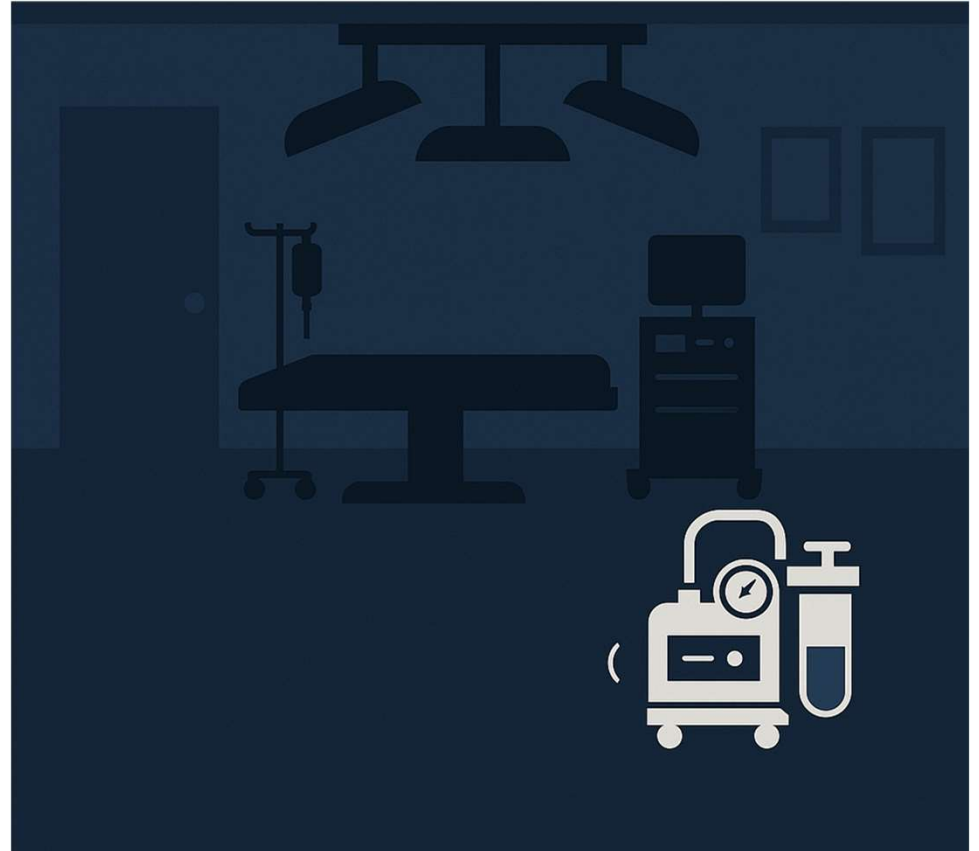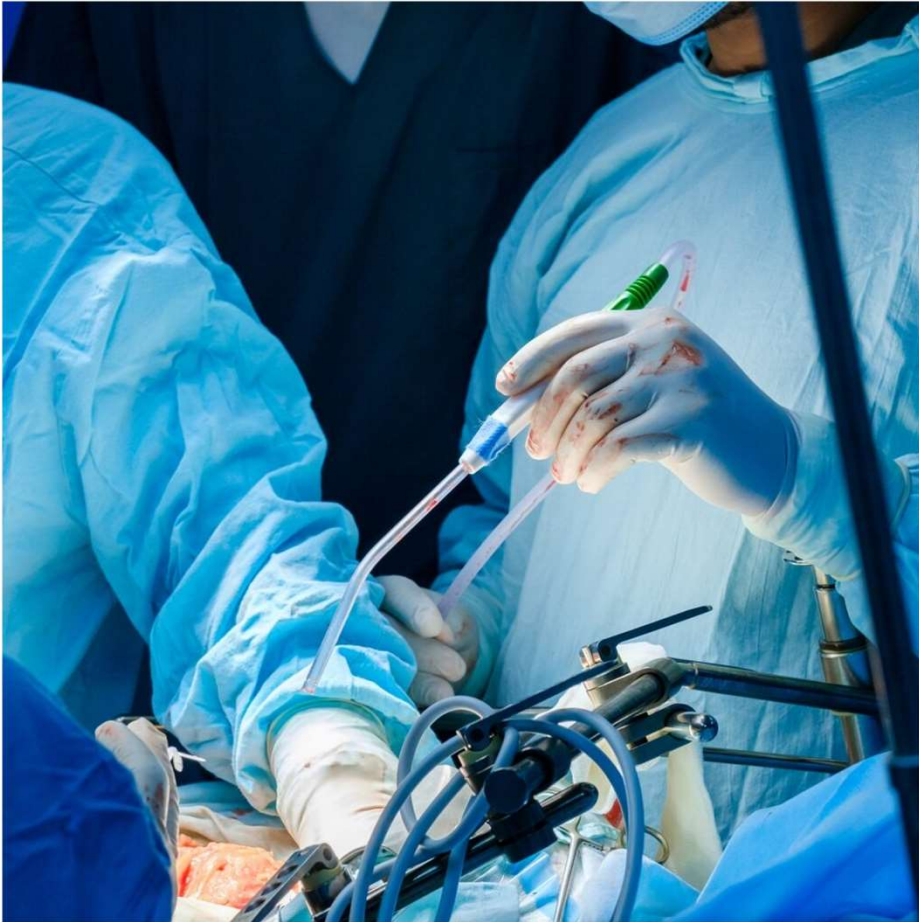
COLUMBIA ENGINEERING

Now picture this…

Now **picture this...**

Suction left on in the OR is money and energy being drained — literally.

Suction is unnecessarily left on for ~35% of its current runtime.

Financial Impact

Equipment Lifespan

Maintenance Costs

Electricity

Carle Illinois
COLLEGE OF MEDICINE

Carle ILLINOIS

Financial Impact

Equipment Lifespan

- Replacement vacuum systems cost **$100-750k.**[2]
- Replacement filters cost **$2,500-10,000.**[2]

Maintenance Costs

- Hospitals spend an estimated **$8,000** annually on oil changes for vacuum systems.[3]

Electricity

- Hospitals spend an estimated **$30,835** annually on electricity for vacuum systems.

Carle Illinois
COLLEGE OF MEDICINE

Carle I ILLINOIS

Environmental Impact

- The global health care industry is responsible for **5% of worldwide greenhouse gas emissions.**[4]

- The World Health Organization projects that the **direct health costs of climate change will be $2-4 billion per year** by 2030.[4]

Leaving suction on overnight contributes to ~**8 billion kg CO_2 emissions** globally per year.

Carle Illinois
COLLEGE OF MEDICINE

Carle **I** **ILLINOIS**

"Unnecessary suction use is a **huge problem and constant headache** because it **prematurely ages the vacuum pumps, causes more oil changes, and uses extra electricity.**"

- Carle Hospital Facilities Managers

"Unnecessary suction use is a **huge problem and constant headache** because it **prematurely ages the vacuum pumps, causes more oil changes, and uses extra electricity.**"

- Carle Hospital Facilities Managers

Needs Statement

A way to **detect and alert when suction is unnecessarily left on in operating rooms** (such as overnight when there are no ongoing surgeries), in order to **extend vacuum equipment lifespan, reduce energy consumption, and lower both hospital operational and capital costs.**

SuctionSense

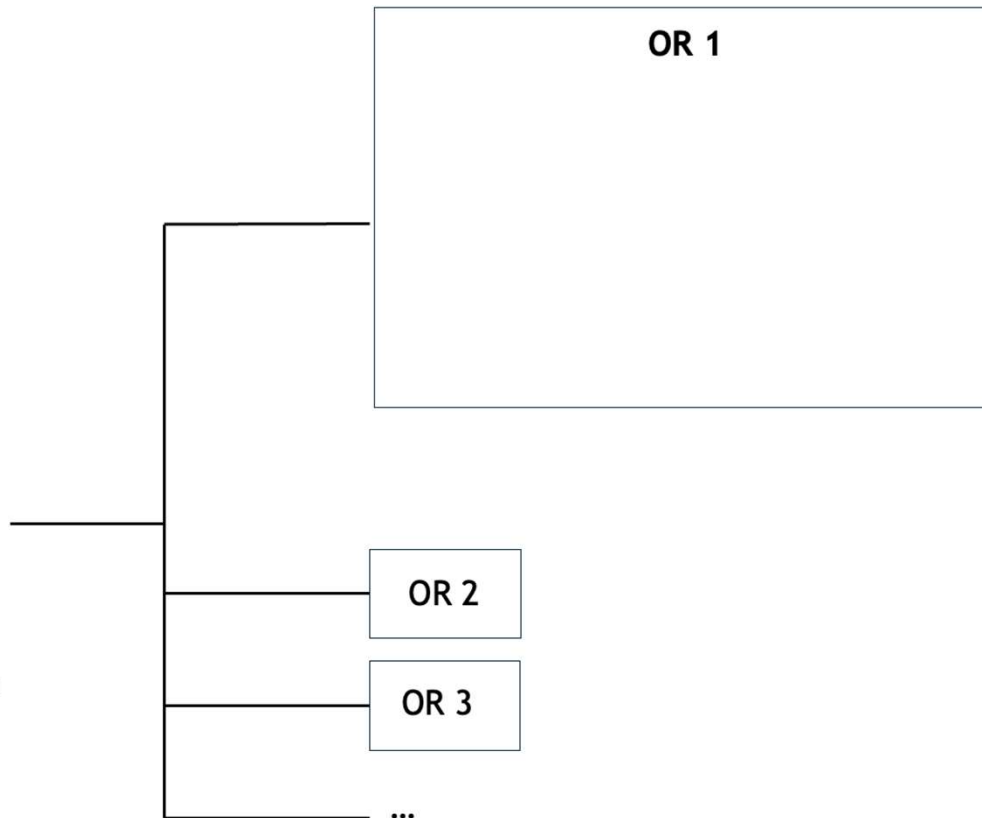A smart alert system for efficient OR suction management
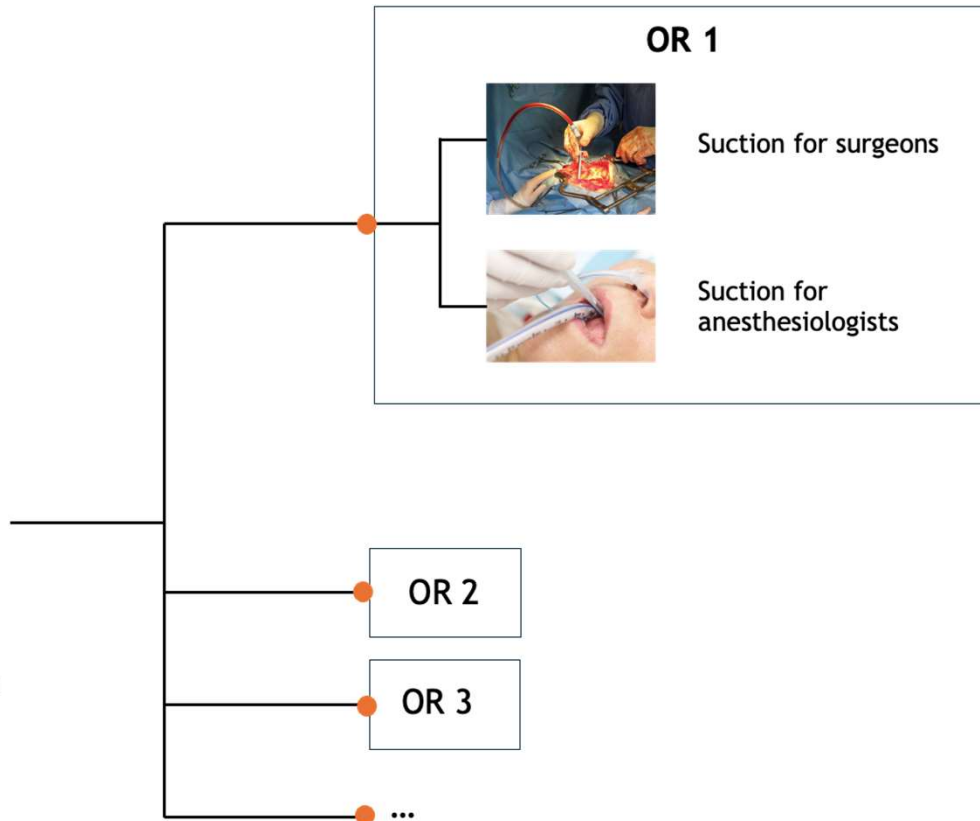
Carle Illinois
COLLEGE OF MEDICINE

Carle   **I ILLINOIS**
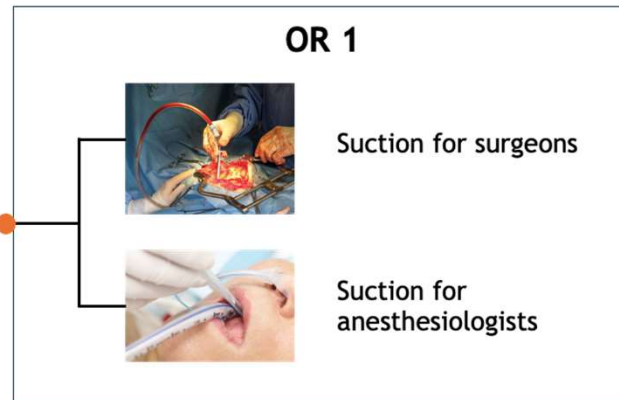
Where It Fits into the Hospital Vacuum System

OR 1

OR 2

OR 3

...

Centralized vacuum system

Carle Illinois
COLLEGE OF MEDICINE

Carle I ILLINOIS

Where It Fits into the Hospital Vacuum System

OR 1

Suction for surgeons

Suction for anesthesiologists

Centralized vacuum system

OR 2

OR 3

...

Where It Fits into the Hospital Vacuum System

OR 1

Suction for surgeons

Suction for anesthesiologists

Centralized vacuum system

OR 2

OR 3

Amico
Medical Gas Shut-Off Valves

OXYGEN

MEDICAL AIR

MEDVAC

Close Valves Only In Emergency

Where It Fits into the Hospital Vacuum System

OR 1

Suction for surgeons

Suction for anesthesiologists

Centralized vacuum system

OR 2

OR 3

Carle Illinois
COLLEGE OF MEDICINE

Original

With SuctionSense

Original

With SuctionSense

ESP32 microcontroller

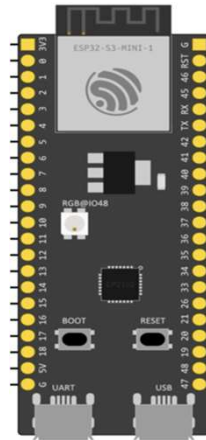Pressure transducer

OXYGEN

MED AIR

MED VAC

SucSense

Design Schematic

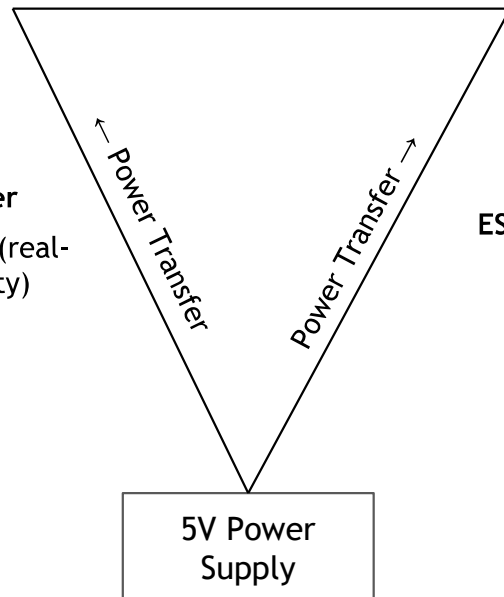**Pressure Transducer**

- Measures pressure (real-time suction activity)

← Power Transfer

Power Transfer →

ESP32 Microcontroller

5V Power Supply

Design Schematic

Pressure Transducer

- Measures pressure (real-time suction activity)
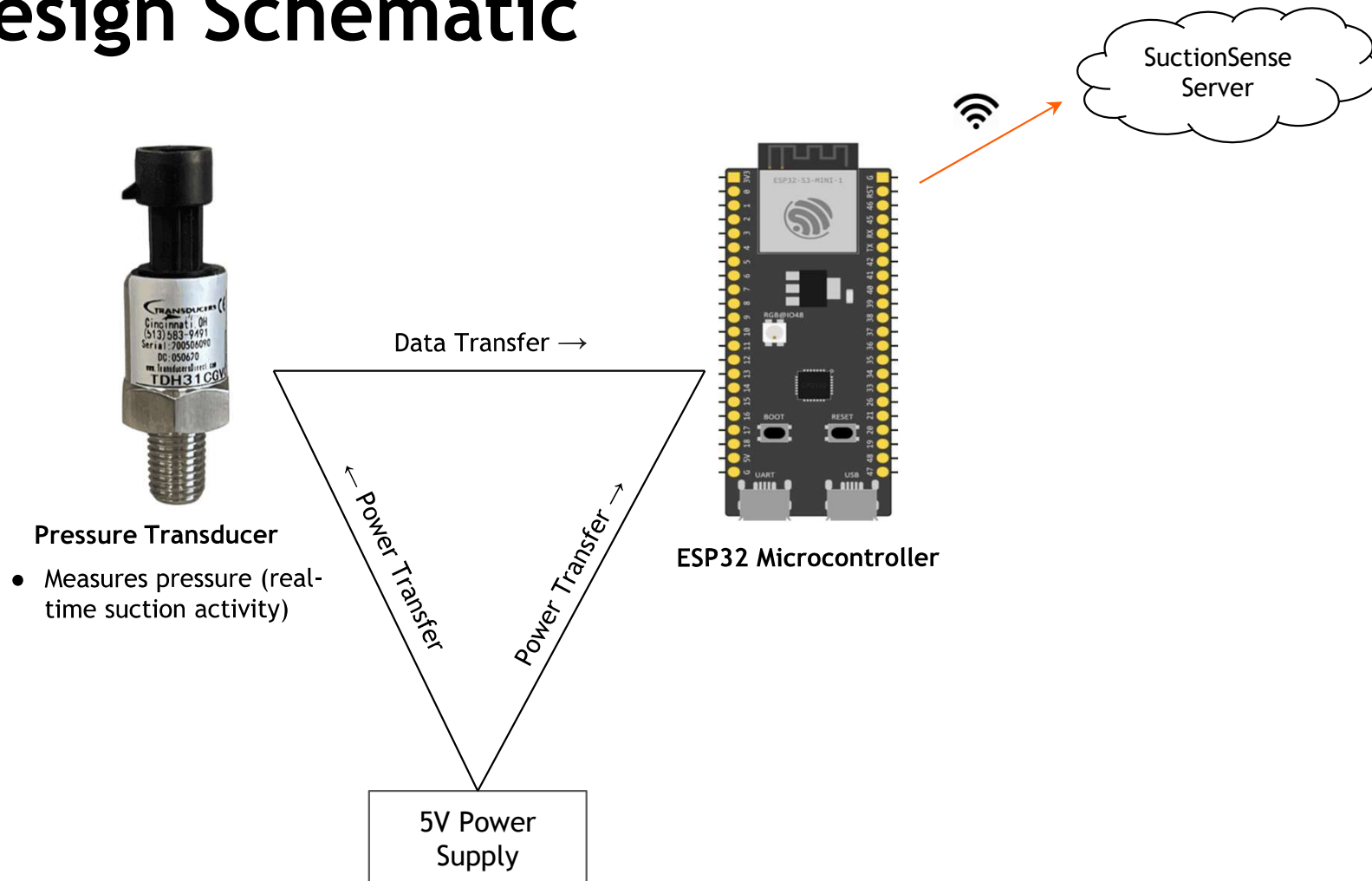
Data Transfer →

← Power Transfer

Power Transfer →

ESP32 Microcontroller

5V Power Supply

Design Schematic

Pressure Transducer

- Measures pressure (real-time suction activity)

Data Transfer →

← Power Transfer

Power Transfer →

ESP32 Microcontroller

5V Power Supply

SuctionSense Server

Design Schematic

Pressure Transducer

- Measures pressure (real-time suction activity)

Data Transfer →
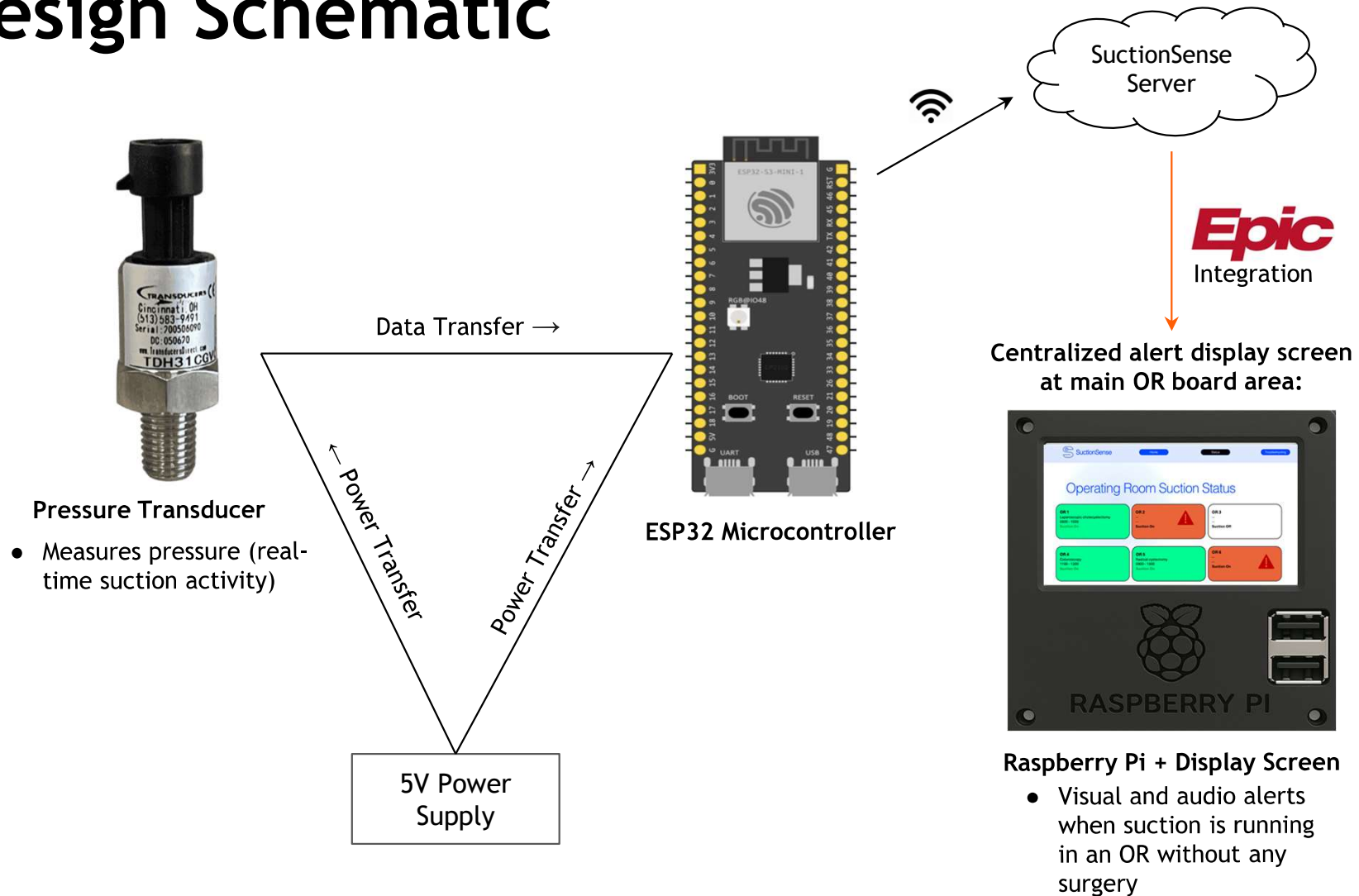
← Power Transfer

Power Transfer →

5V Power Supply

ESP32 Microcontroller

SuctionSense Server

Epic Integration

Centralized alert display screen at main OR board area:

Raspberry Pi + Display Screen

- Visual and audio alerts when suction is running in an OR without any surgery

Design Schematic

Pressure Transducer

- Measures pressure (real-time suction activity)

Data Transfer →

← Power Transfer

Power Transfer →

5V Power Supply

ESP32 Microcontroller

- Low-cost.
- Simple install.
- Scalable across ORs and hospitals.

SuctionSense Server

2 Epic
Integration

Centralized alert display screen at main OR board area:

Operating Room Suction Status

Raspberry Pi + Display Screen

- Visual and audio alerts when suction is running in an OR without any surgery

1   or OR motion sensor
Sharon Chao, 5/27/2025

2   test with OR simulator @ Carle
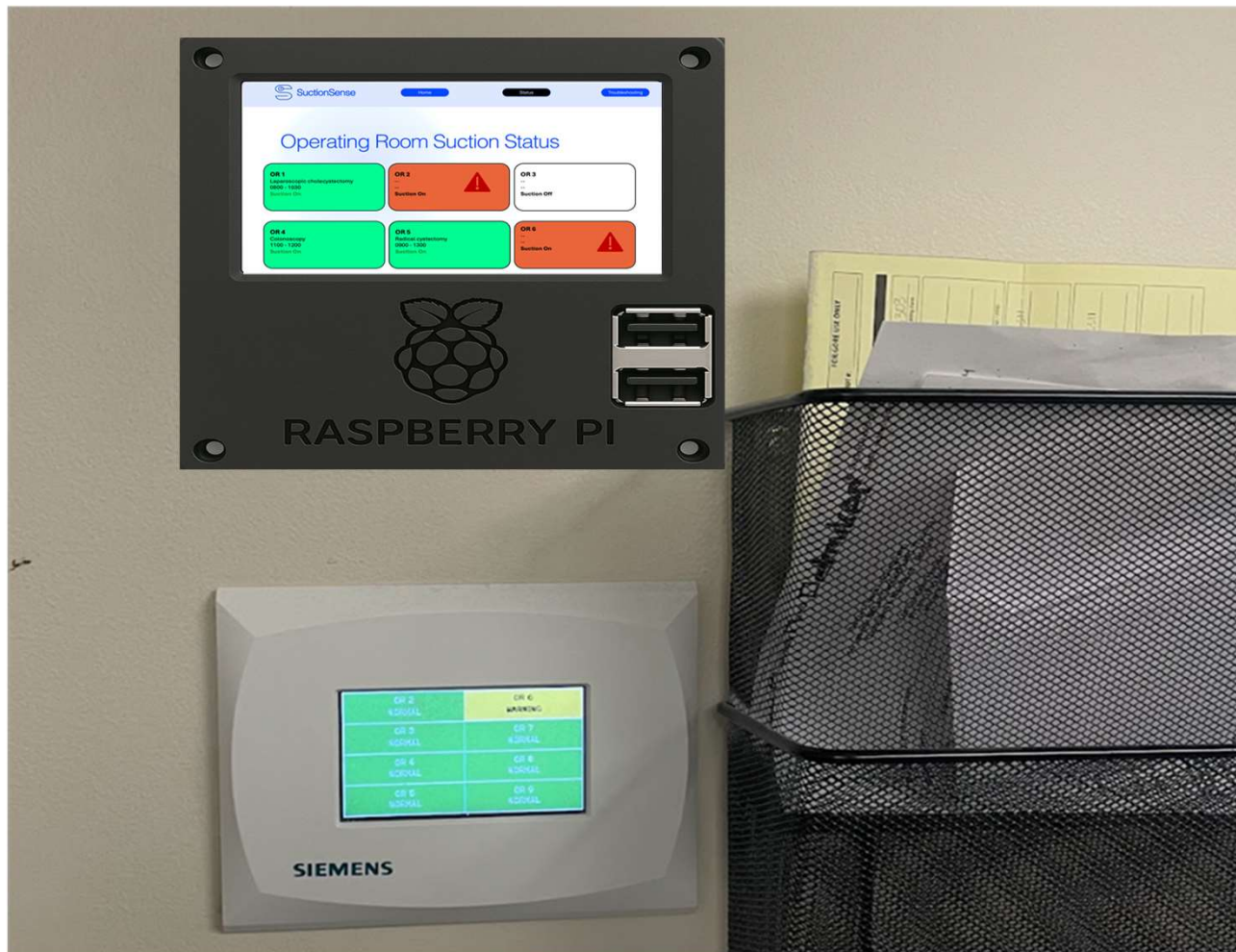Sharon Chao, 5/27/2025
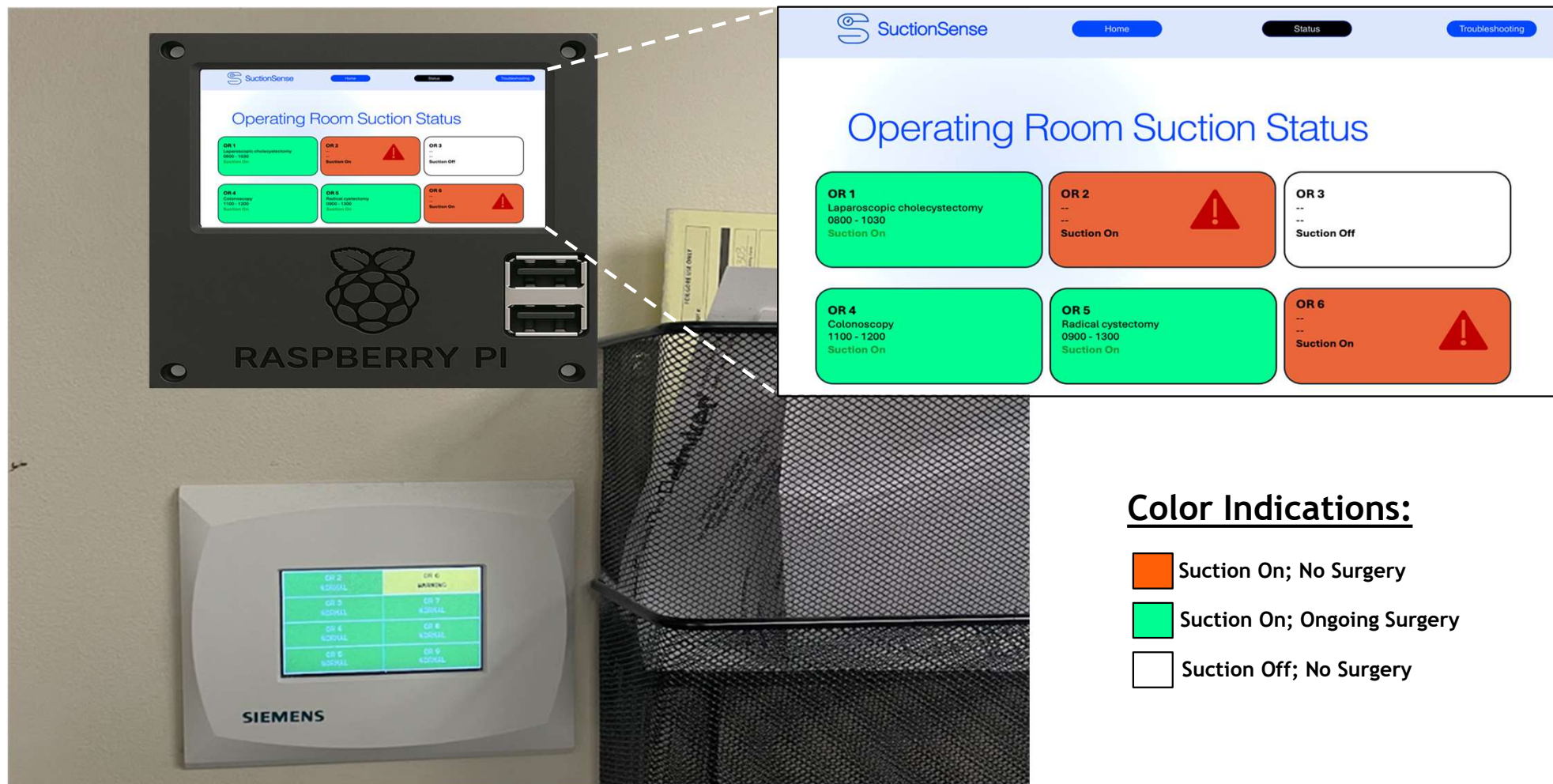
Integration with Epic

Build app on

Read-Only Access (OR Schedule)
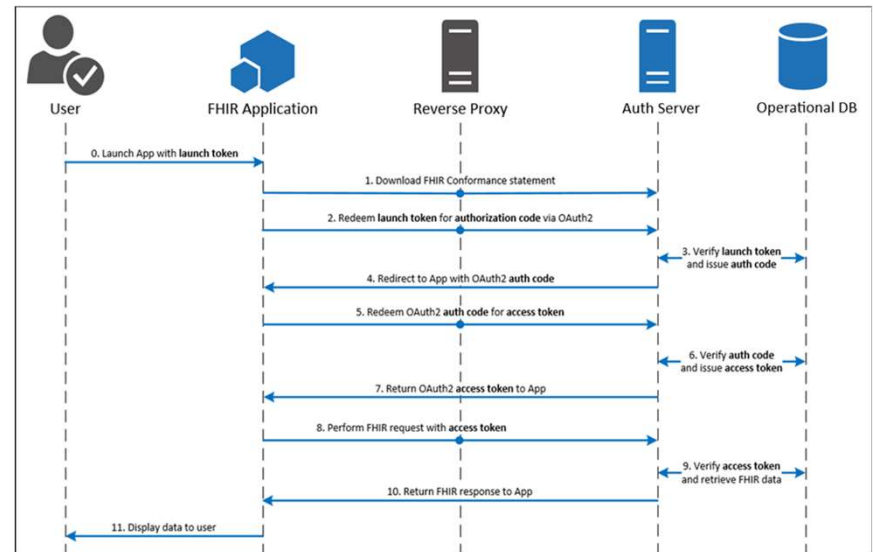
Centralized Alert Display Screen: Near Main OR Board Area

Centralized Alert Display Screen: Near Main OR Board Area

Color Indications:

🟧	Suction On; No Surgery
🟩	Suction On; Ongoing Surgery
⬜	Suction Off; No Surgery

3   intermediate yellow color for suction left on, but before red
Sharon Chao, 5/27/2025

4   + remote alert display display screen for hospital facilities
Sharon Chao, 5/27/2025

Target Customer: Hospitals

Validated Market Interest:

CarleHealth

Hospital Sisters HEALTH SYSTEM
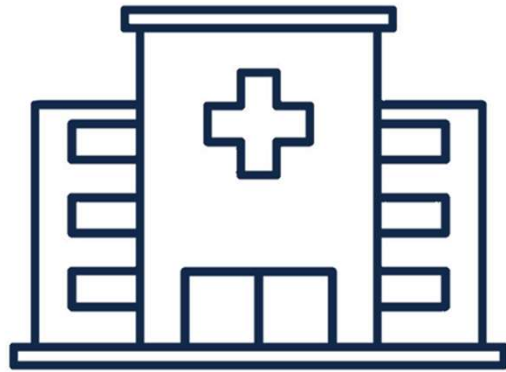
- **6,100** hospitals in the U.S.; **38,600** ORs

- **212,000** hospitals worldwide; **405,000** ORs
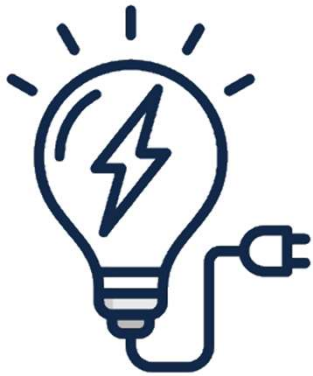
Carle Illinois
COLLEGE OF MEDICINE

Carle · **I ILLINOIS**

Estimated Annual Savings for each Hospital

Lowers vacuum system electricity use by **35%**, saving **$10,793**/year.

Extends vacuum system equipment lifespan by **50%**, saving **$4,200**/year.

Reduces oil change and filter replacement frequency by **25%**, saving **$4,500**/year.

Total: $19,493 saved per year for each hospital

Manufacturing Cost

Device Component	Cost
ESP-WROOM 32 Development Board 2.4GHz Dual-Mode WiFi + Bluetooth	$10.00
TDH31 Vacuum Pressure Transducer	$125.00 x (8)
5V Power Supply Adapter for ESP32	$9.00 x (8)
Raspberry Pi	$35.00
Raspberry Pi Screen Enclosure	$20.00
T connector	$1.60
Total Cost/Hospital: $1,138.00	