CS 439: Wireless Networking

IoT Applications

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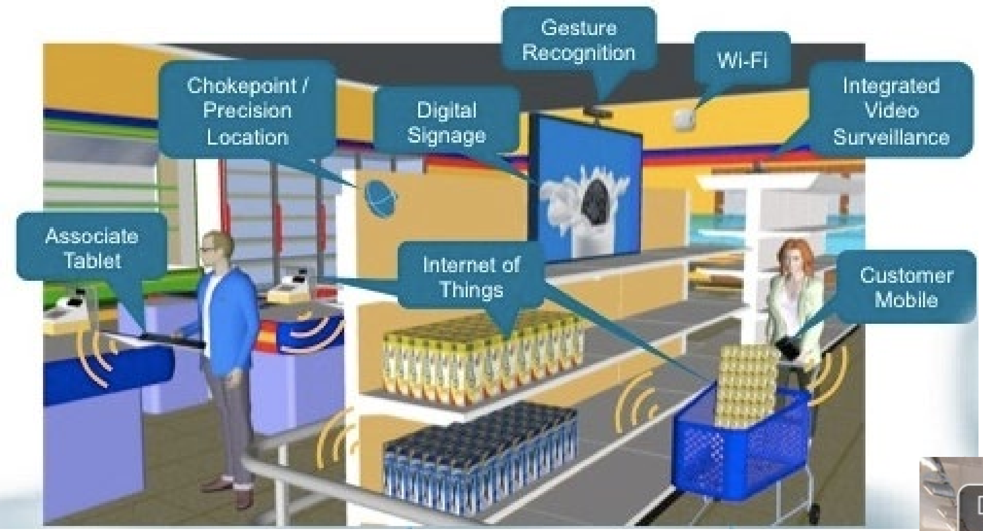
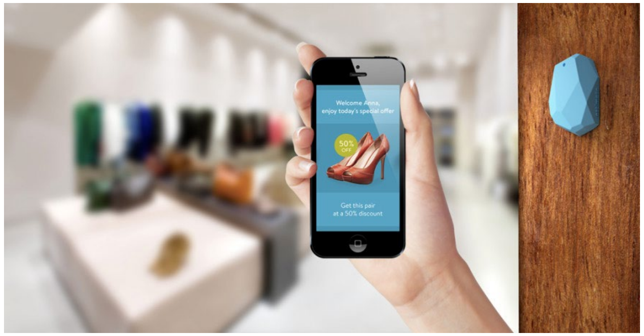
Scenario: Smart Retail




Welcome Anna, enjoy today's special offer
50% OFF
Get this pair at a 50% discount

Use technology to enhance the user's personal and social experience and
the company's business potential

Scenario: Smart Retail

Honey Nut Cheerios
Multi Grain Cheerios
Cheerios

Goals

Product identification and information
Directed coupons and discounts

Scenario: Smart Retail

Honey Nut Cheerios
Multi Grain Cheerios
Cheerios

Challenges

Product detection
Channel contention

Scenario: Smart Retail

Localized IoT Hub

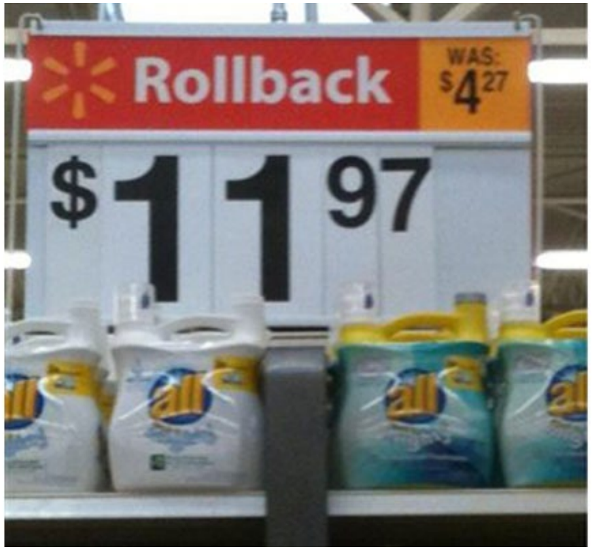
User-to-Hub Personalized Shopping

Scenario: Smart Retail

Localized IoT Hub

Hub-to-Product Inventory control and device management

IoT-enabled Inventory Management



Labeling/inventory systems are prone to error

IoT-enabled Inventory Management

Labeling/inventory systems are prone to error

Automate label on shelf based on BLE label in products

Product Tracking

What should the shelf label display?

Product Tracking

What should the shelf label display?

Find nearest product

Product Tracking

What should the shelf label display?

Find nearest product

Is standard ranging-based localization enough?

Product Tracking

What should the shelf label display?

Find nearest product

Is standard ranging-based localization enough?

Not accurate enough for small shelf spacing and small products

Product Tracking

But absolute location is not necessary

Product Tracking

But absolute location is not necessary

Need a nearness ordering!

Relative location instead of absolute location

Relative Proximity

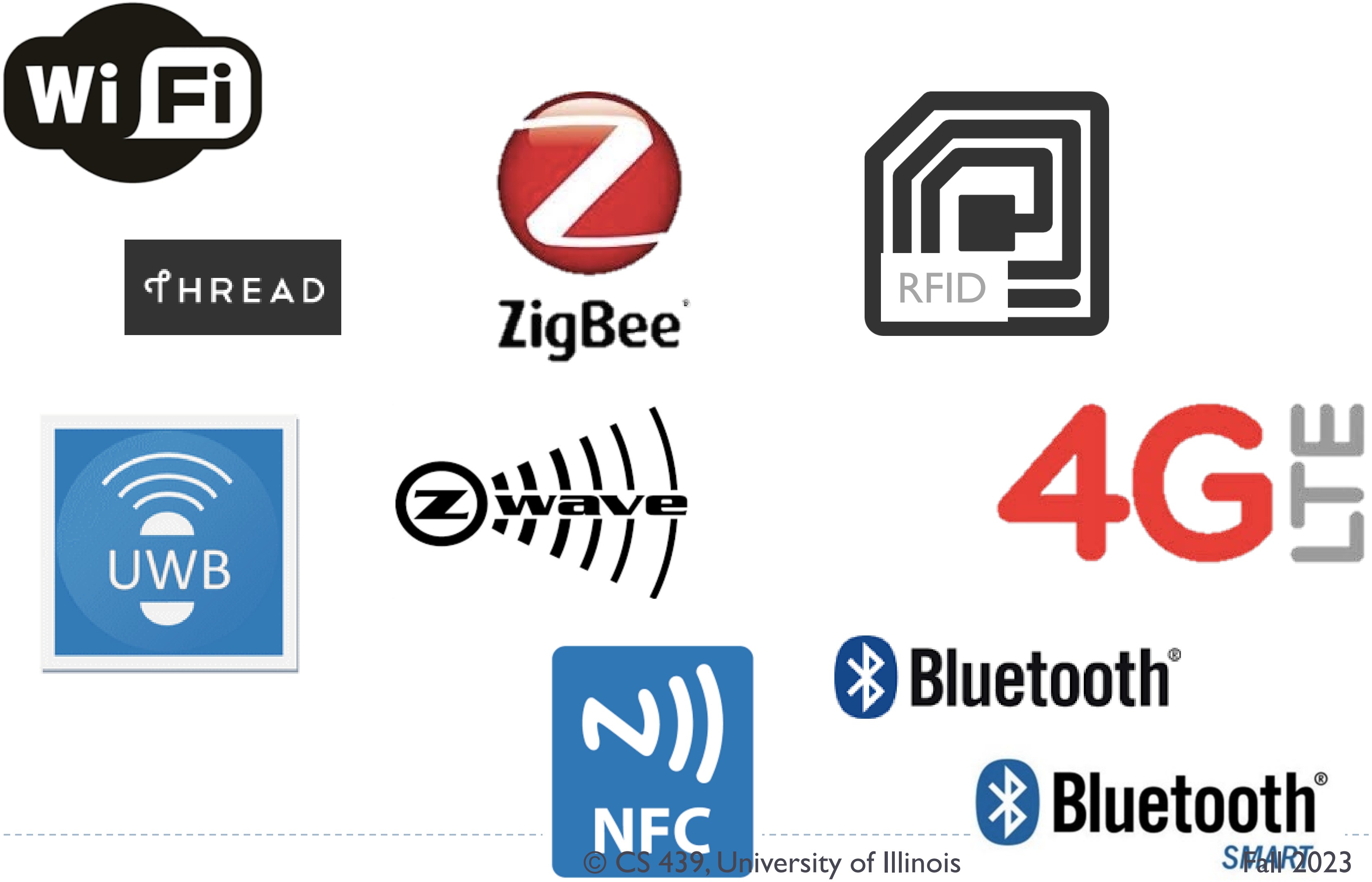
Honey Nut Cheerios
Multi Grain Cheerios
Cheerios

What product is closest to me?

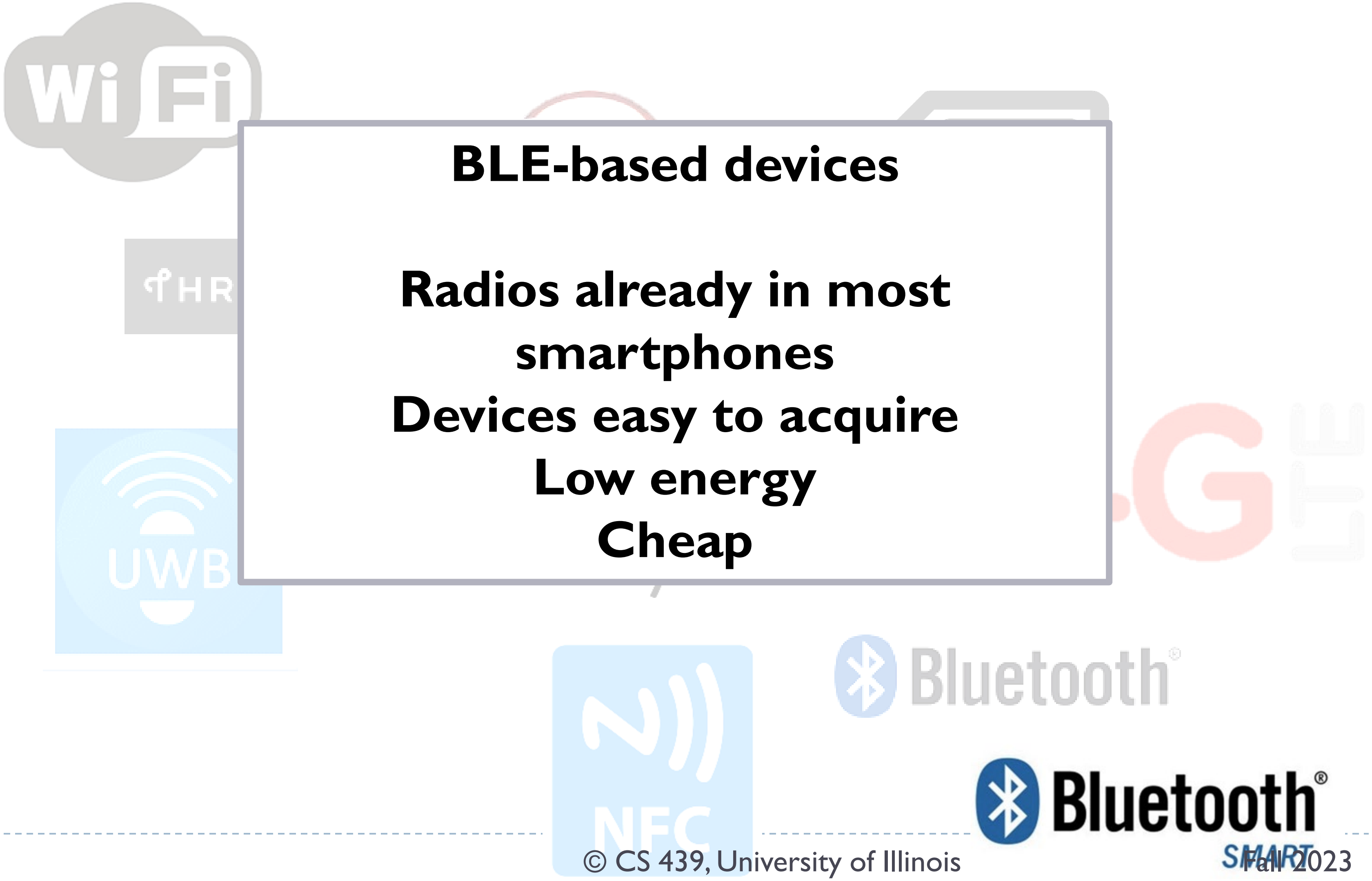
Relative Proximity

What is the best wireless technology to use?

Which Technology best fits IoT?



Which Technology best fits IoT?

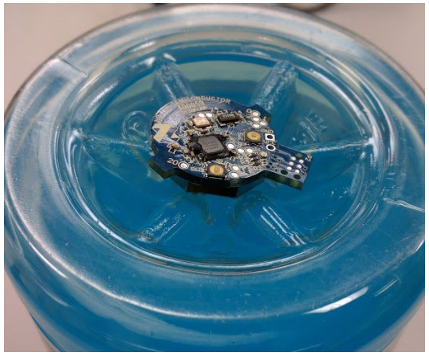


BLE-based devices

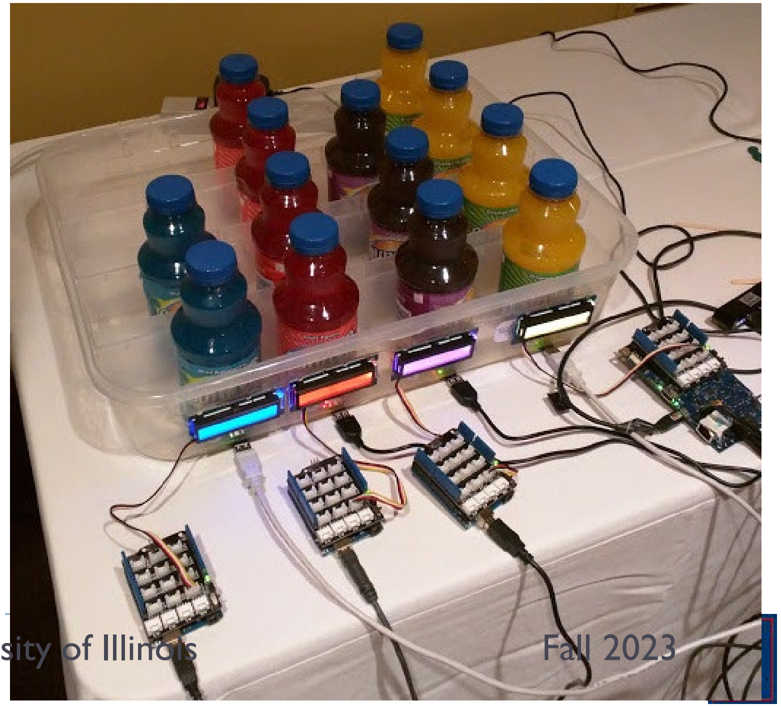
Radios already in most smartphones
Devices easy to acquire
Low energy
Cheap

The Smart LaBLE System

Attach BLE tags to each product

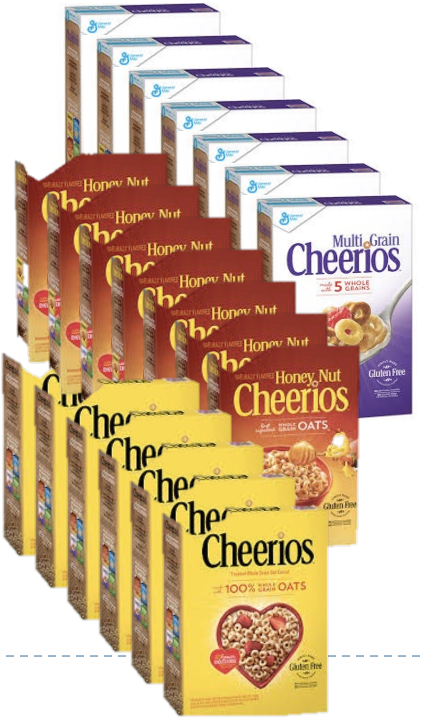


Smart LaBLEs
Build nearness ordering
Display product info related to nearest product
Update every minute



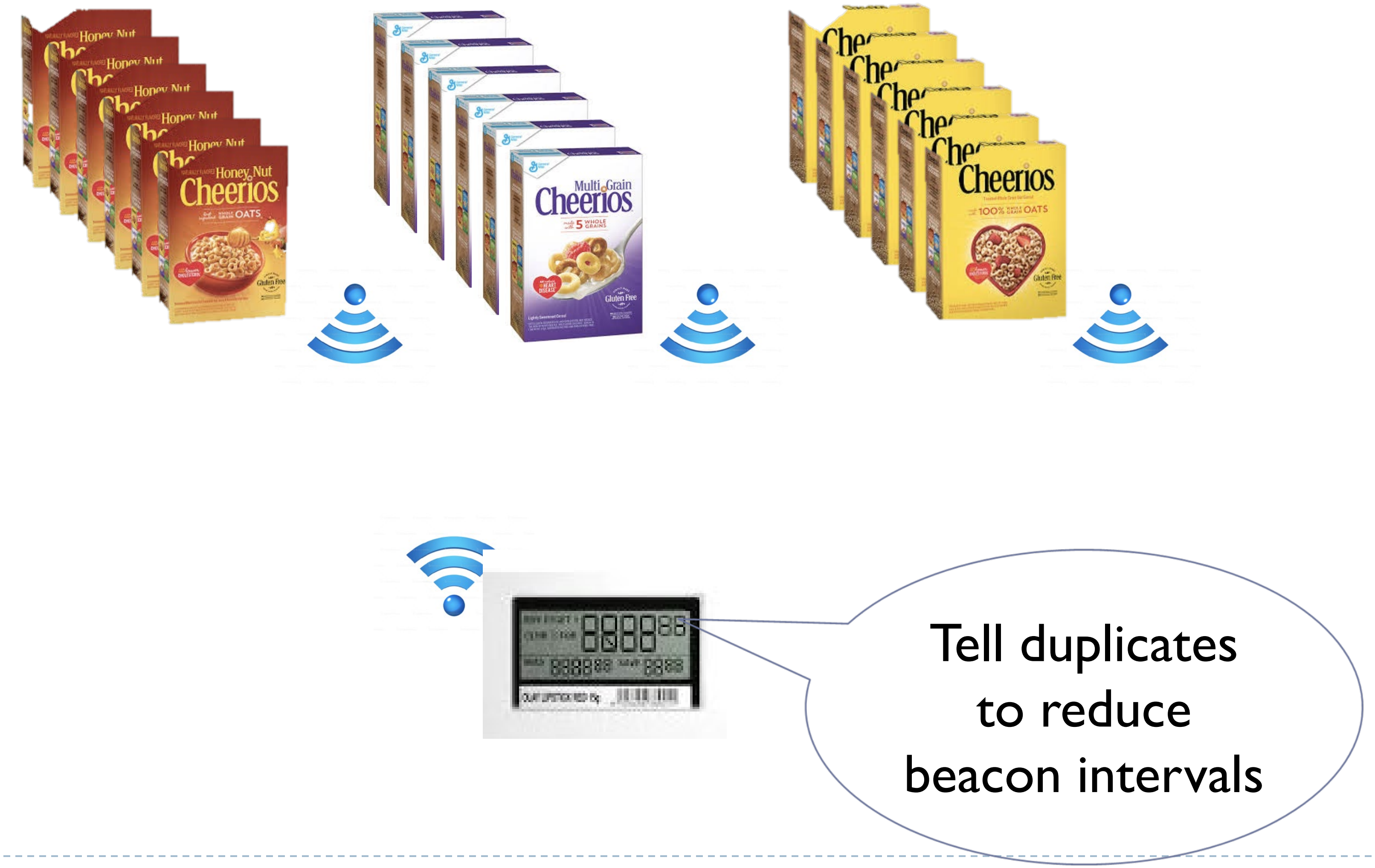
Product Tagging in Dense Environments

Low-frequency beaconing
Conserves energy
Reduces contention



Not all products need to beacon frequently!

Smart LaBLEs in Dense Environments



Tell duplicates to reduce beacon intervals

Smart LaBLEs in Dense Environments

Challenges

Dynamic configuration

BLE devices save energy in transmit only mode

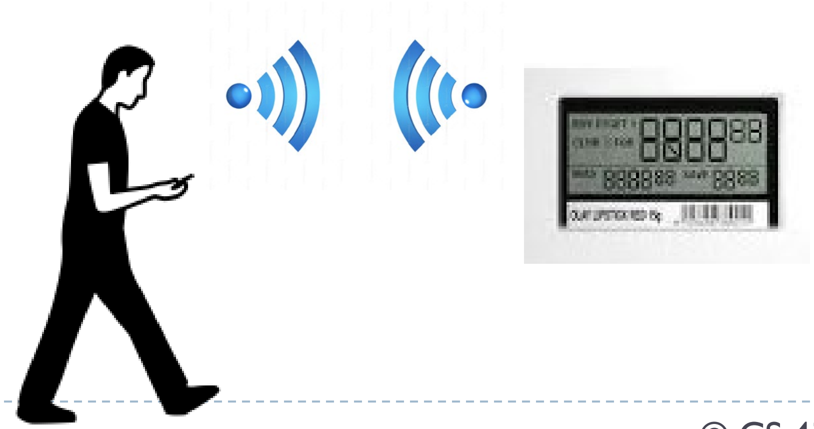
Directed Advertisements

Target specific users/groups with customized information

Directed Advertisements

Challenge: Information overload

Encryption/Decryption can be expensive
Checking every packet cryptographically wastes time and energy
Store environments can serve many users



Directed Advertisements

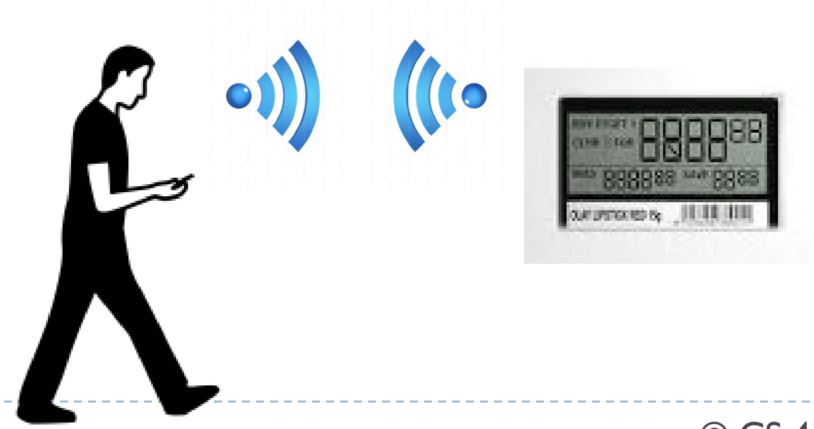
Challenge: Information overload

How do we balance allowing users to know which advertisements are for them without breaking our security model?

Directed Advertisements

Challenge: Servicing Many Users

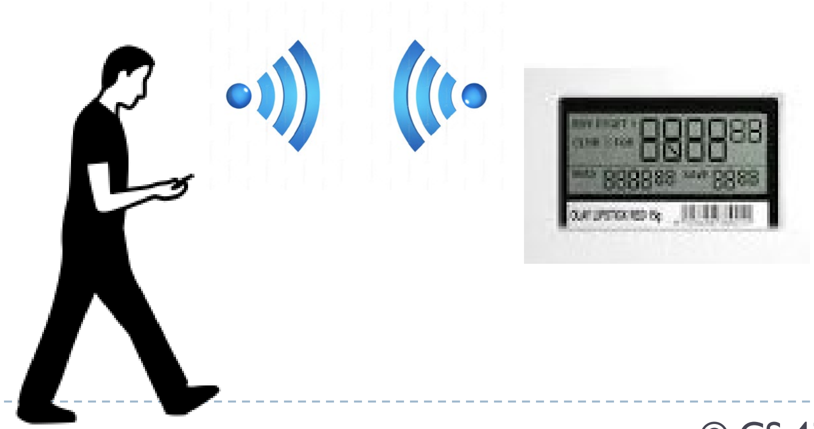
Limited bandwidth
Limited communication range
Selecting potential users



Directed Advertisements

Challenge: Servicing Many Users

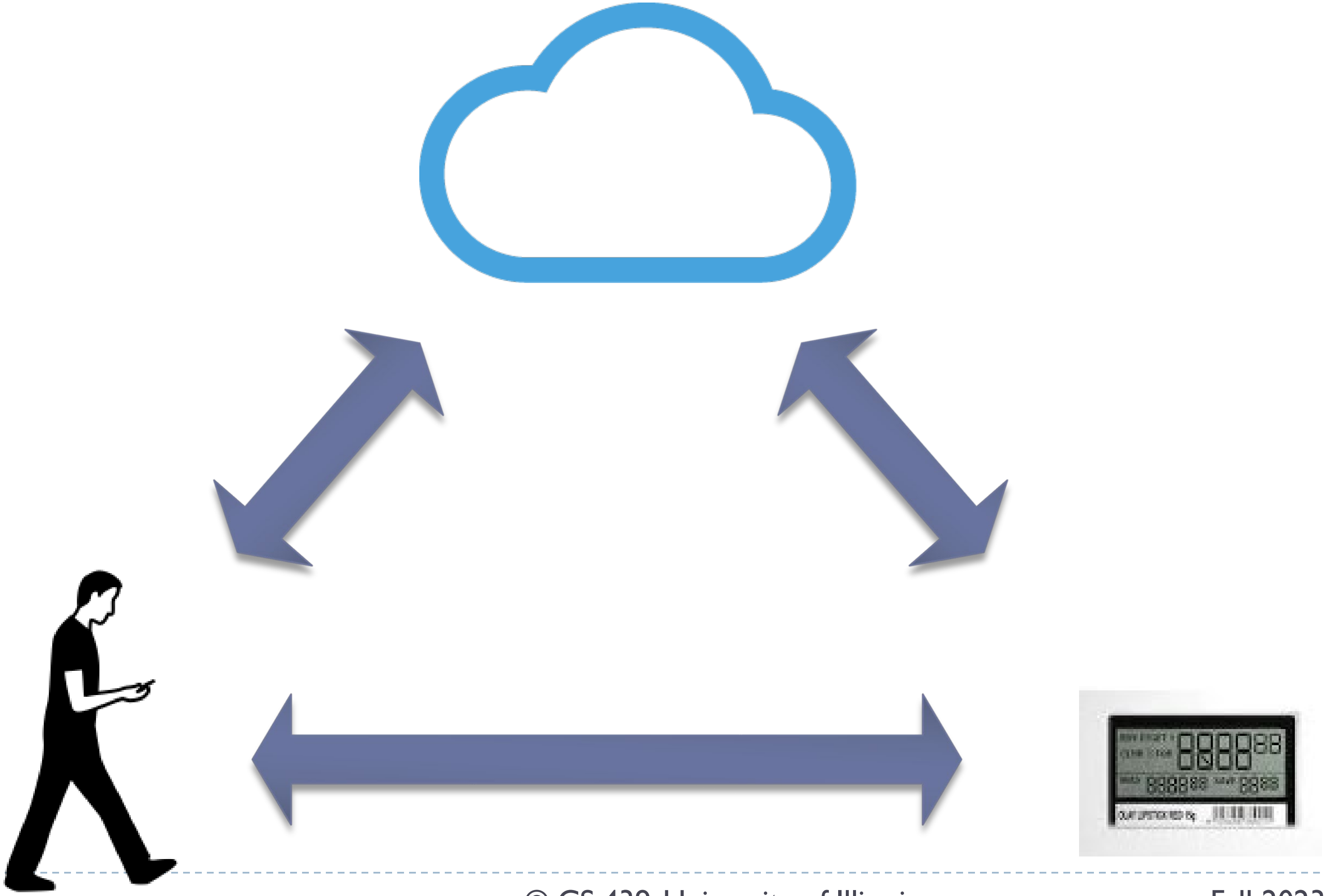
How does the store broadcast enough information to support all potential users?



Directed Advertisements

- Current directions
  - Which packets are for me?
    - User-specific or group-based pairings, need to listen to all
    - Each is assigned a unique id, encoded into a bitmap
    - Given limited BLE payload, bitmap must be hashed to fit
  - Too many users
    - Use embedded, hardware-based implementations of our cryptographic algorithms
      - □ Cheap parts, easily added to devices
      - □ Expose simple primitives for easy application design

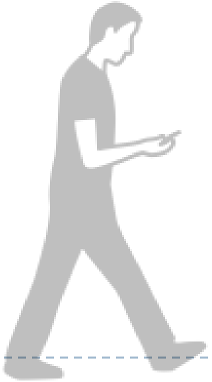
Prototype Retail System



Prototype Retail System

Cloud application

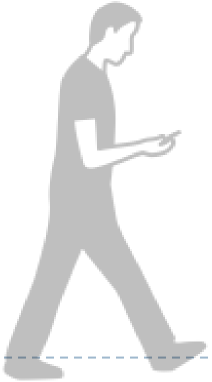
Manage user's key material
Maintain store inventory
Determine advertising



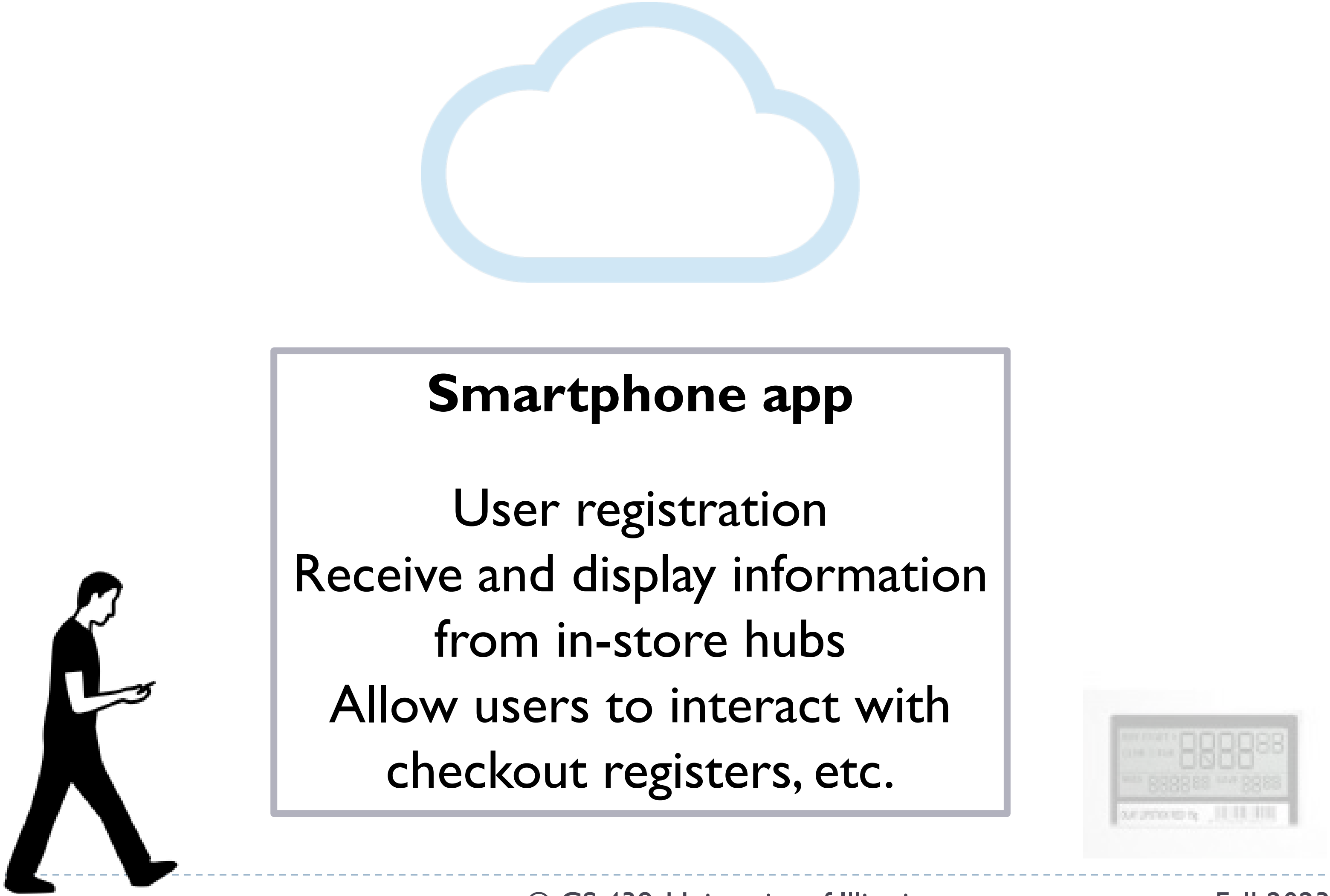
Prototype Retail System

In-store hubs

Custom BLE devices
Aggregate product information
Distribute localized
information Provide
localization and user tracking



Prototype Retail System



Smartphone app

User registration
Receive and display information from in-store hubs
Allow users to interact with checkout registers, etc.