Zipcart

Team 26: Ryan Lagasse, Ricardo Henriquez, Jonathan Azevedo

Team

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Computer Systems

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Electrical

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Motivation

Universal Product Codes (UPCs)

- Unique, twelve-digit numbers that identify items

- Barcodes are machine-readable

Digits	Code
1 – 6	Manufacturer ID
7 – 11	Item ID
12	Check Digit

Challenges

- Read moving barcodes at unpredictable angles

- Operate at the embedded scale

- Done in a way that comes natural to shoppers

Requirements

1. Recognize barcode as item is placed in cart

2. Detect when item is removed from cart

3. Display item list and current balance

4. Detect an unscanned item to prevent theft

5. Sustain power for a full business day

Specifications

1. 18 hours of continuous operation

2. One item entered/removed per two-second interval

3. Barcode surface must be reasonably flat

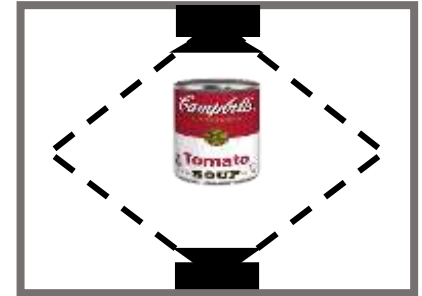4. Maximum system latency: four seconds

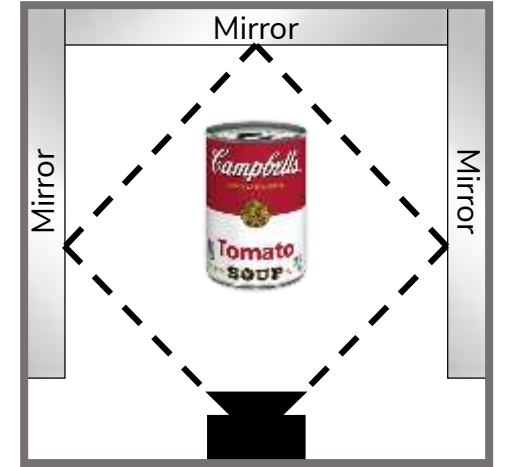# Competitors

Design Alternatives

- Barcode Scanner

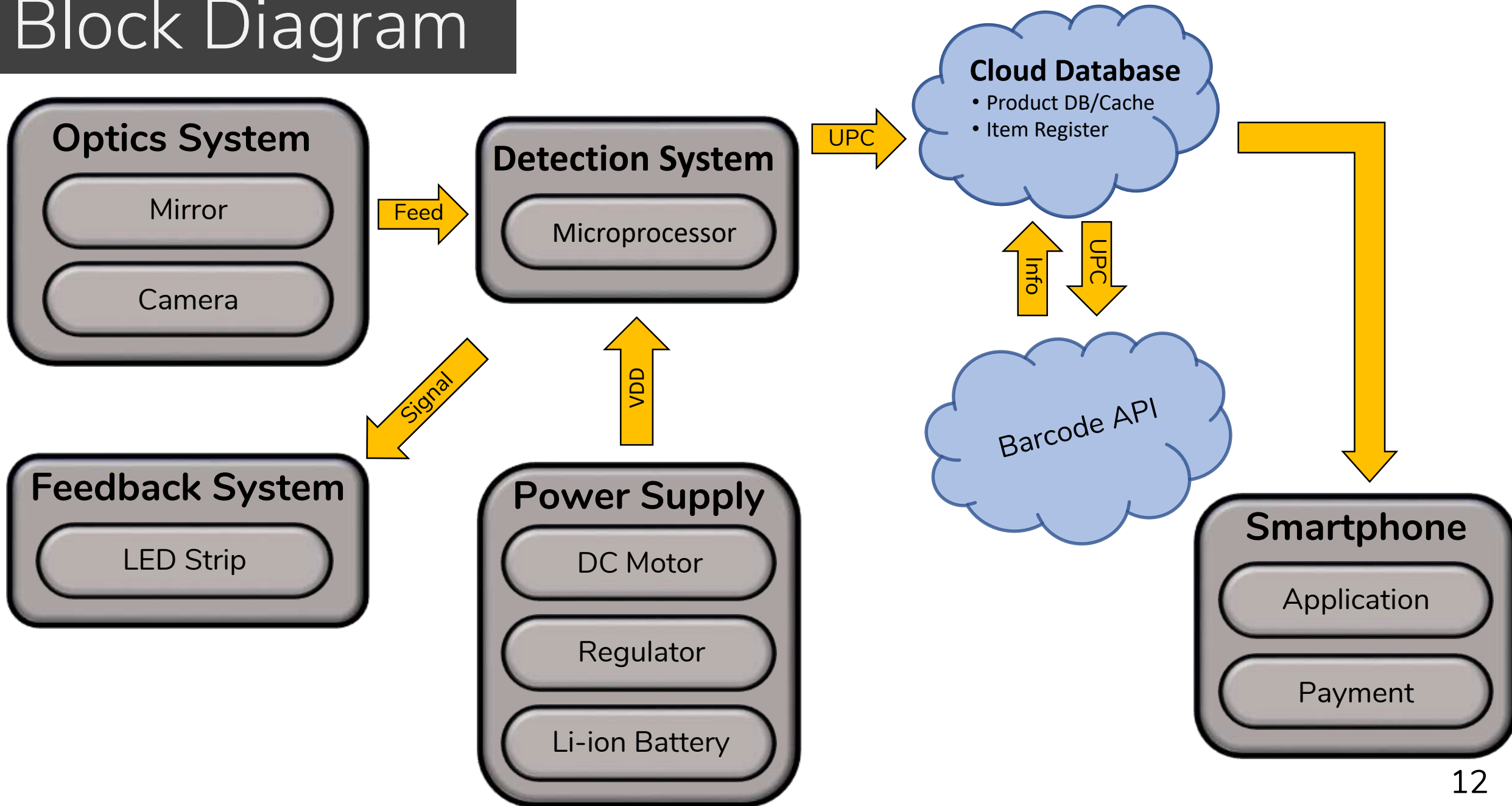- Multiple Cameras

- Dedicated Display Terminal

Our Approach

- Single camera mounted to cart

  - Mirrors used see around product

- Cloud services

  - Intermediary between system and application

- Android smartphone application

  - Display item list and current balance

Block Diagram

Optics System
- Mirror
- Camera

→ Feed →

Detection System
- Microprocessor

→ UPC →

Cloud Database
- Product DB/Cache
- Item Register

↑ Info   ↓ UPC

Barcode API

↓ Signal

Feedback System
- LED Strip

↑ VDD

Power Supply
- DC Motor
- Regulator
- Li-ion Battery

Smartphone
- Application
- Payment

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Block Diagram

Optics System
- Mirror
- Camera

Feed →

Detection System
- Microprocessor

Signal

VDD

Feedback System
- LED Strip

Power Supply
- DC Motor
- Regulator
- Li-ion Battery

UPC →

Cloud Database
- Product DB/Cache
- Item Register

Info *UPC*

Barcode API

Smartphone
- Application
- Payment

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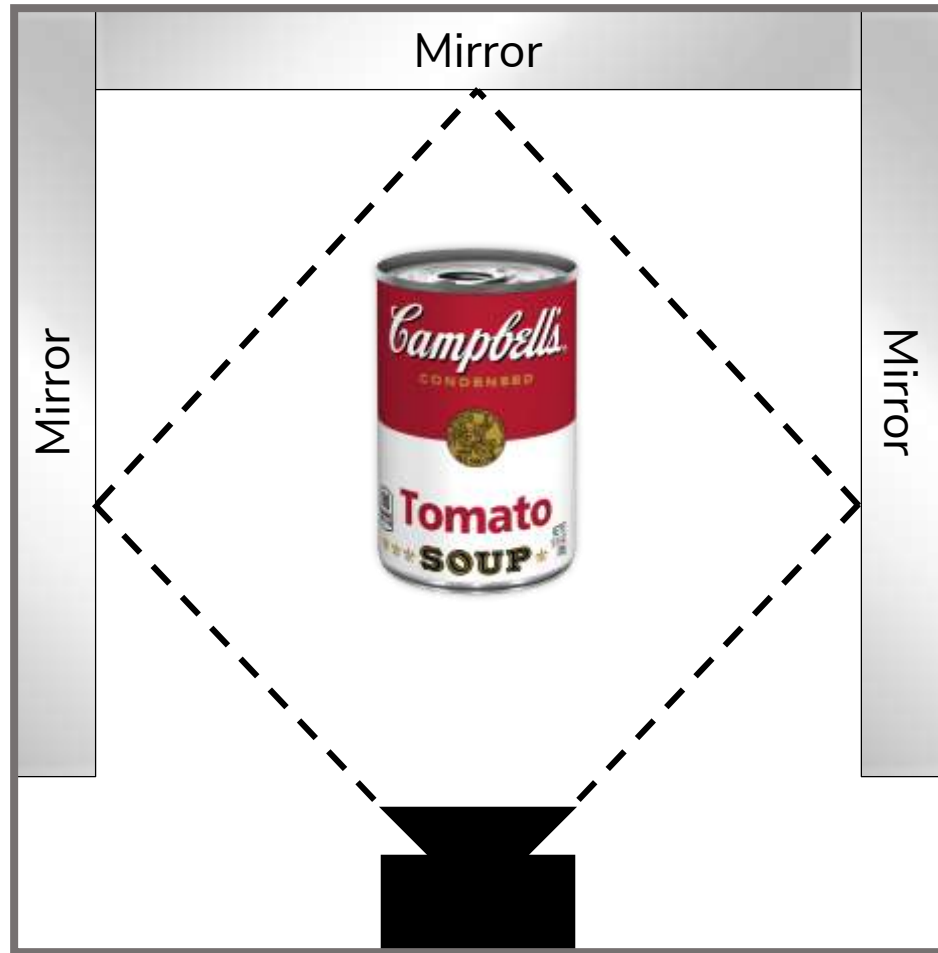
Optics System

Cart, Top-Down Perspective

Front
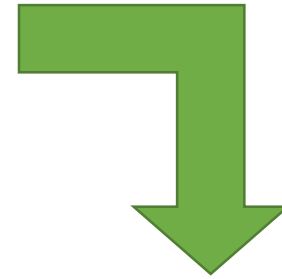
Left

Front

Right

Back

Detection System

Optics System
- Mirror
- Camera

Detection System
- Microprocessor

Feedback System
- LED Strip

Power Supply
- DC Motor
- Regulator
- Li-ion Battery

Cloud Database
- Product DB/Cache
- Item Register

Barcode API

Smartphone
- Application
- Payment

Image

Signal

VDD

UPC

Data
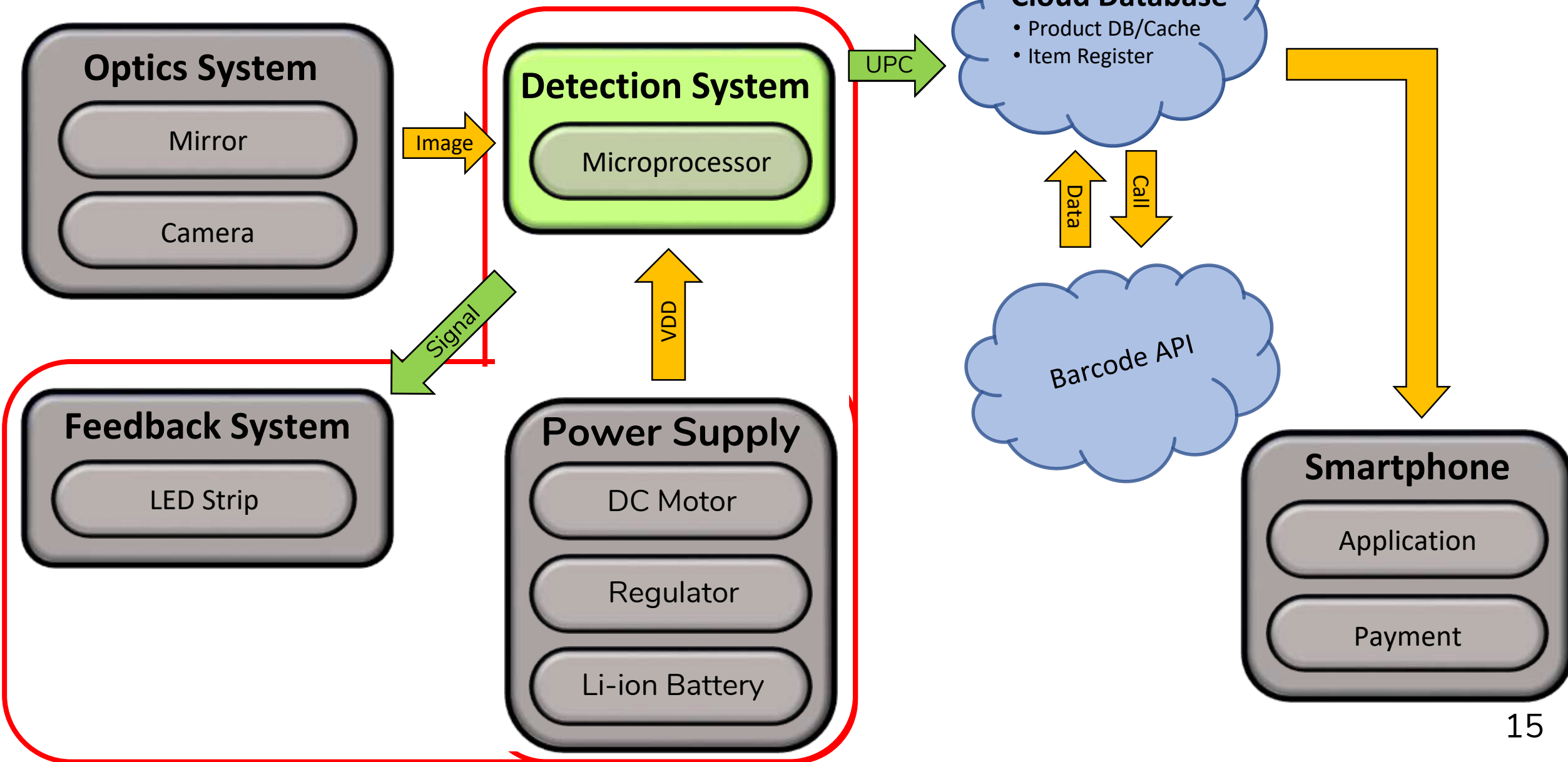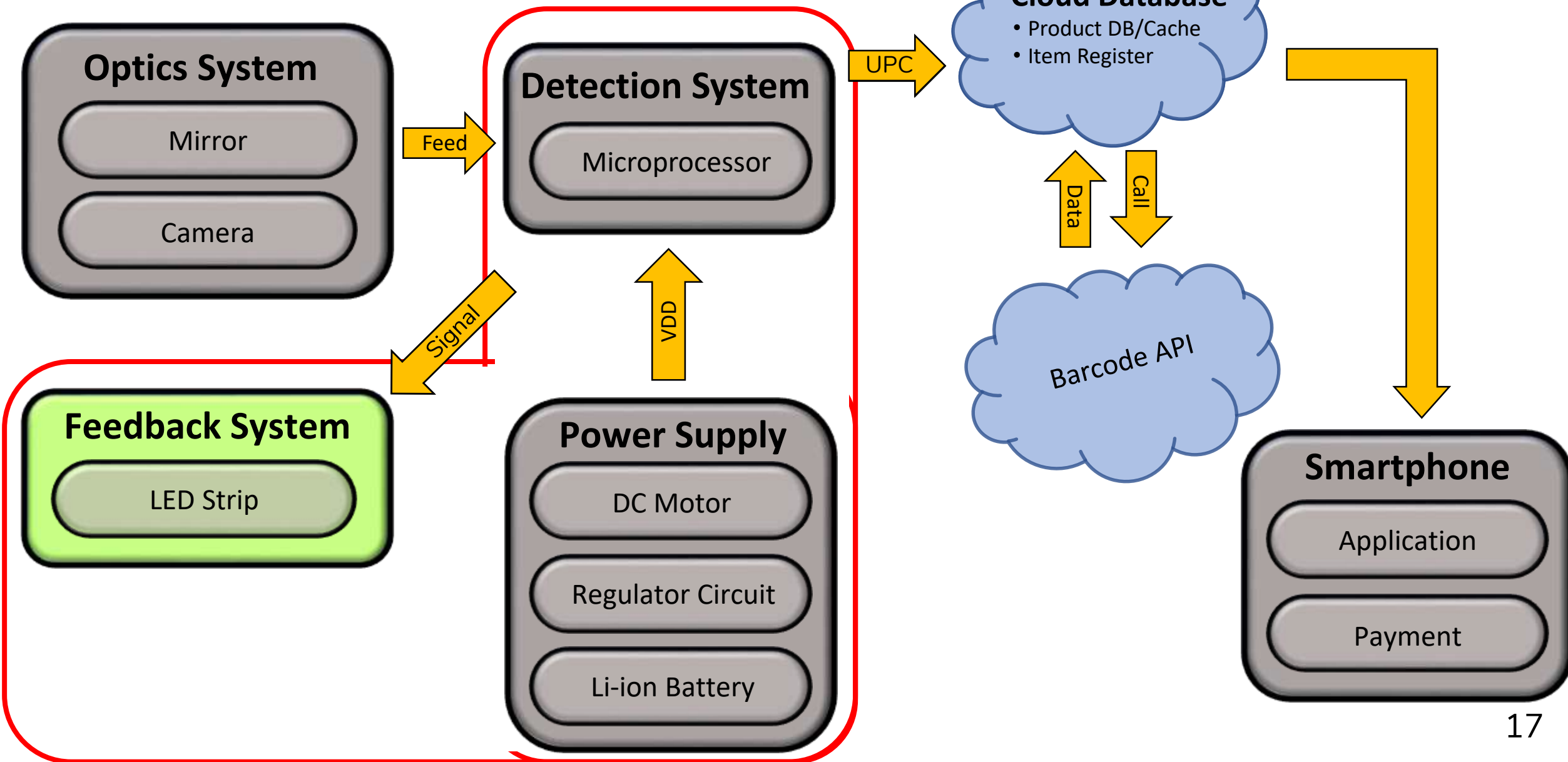
Call

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Detection System

- Computer Vision algorithm

  - Read UPCs from barcodes

- Network interface

  - Send UPC, action to cloud

- Small, embedded platform

```
POST /cloud/order/3214 HTTP/1.1
Ba
    POST /cloud/order/3214 HTTP/1.1
    B
        DELETE /cloud/order/3214 HTTP/1.1
        Barcode: 07314916939
```

Feedback System

Optics System

Mirror

Camera

Feed →

Detection System

Microprocessor

← UPC →

Cloud Database
- Product DB/Cache
- Item Register

Data ↑ Call ↓

Signal

VDD

Barcode API

Feedback System

LED Strip

Power Supply
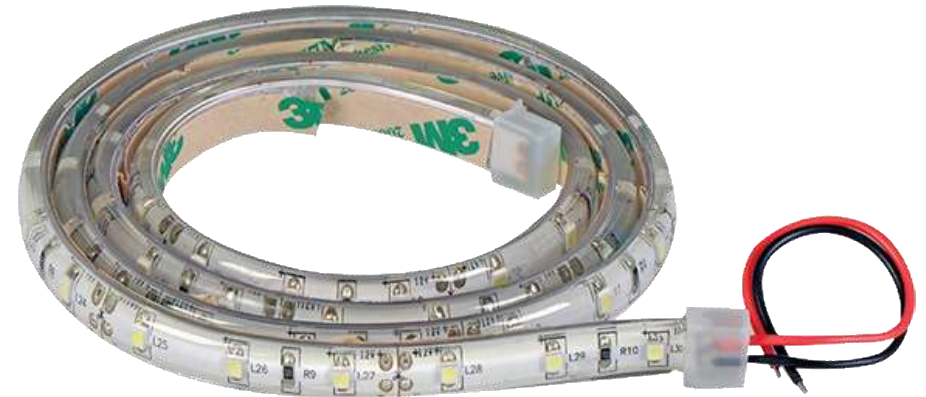
DC Motor

Regulator Circuit

Li-ion Battery

Smartphone

Application

Payment

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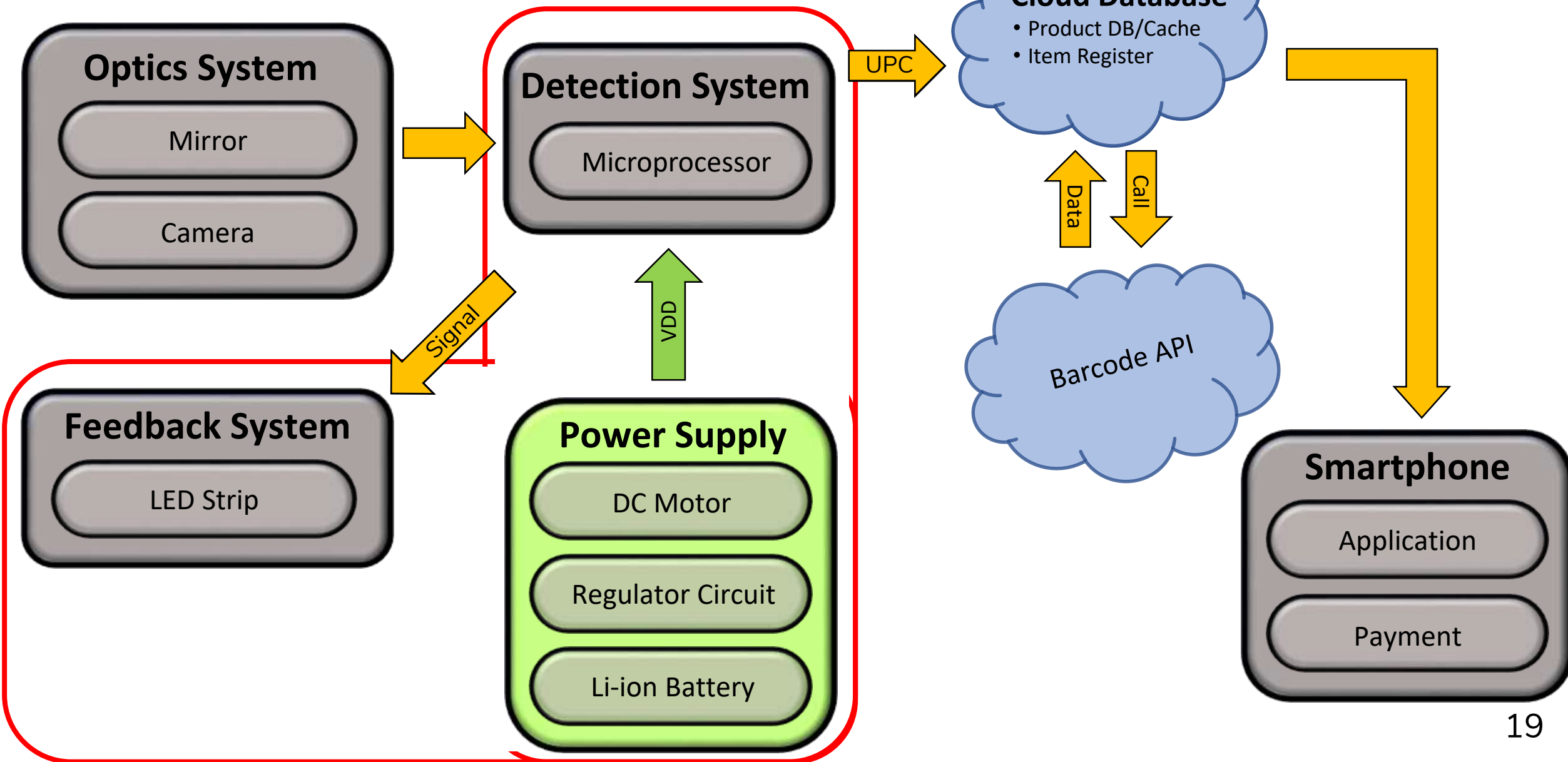
- Intent is to differentiate a good scan from a bad one

- LED strip along inner edge of cart

- Green = good scan

- Red = bad scan

Power Supply

Optics System
- Mirror
- Camera

Detection System
- Microprocessor

Feedback System
- LED Strip

Power Supply
- DC Motor
- Regulator Circuit
- Li-ion Battery

Cloud Database
- Product DB/Cache
- Item Register

Barcode API
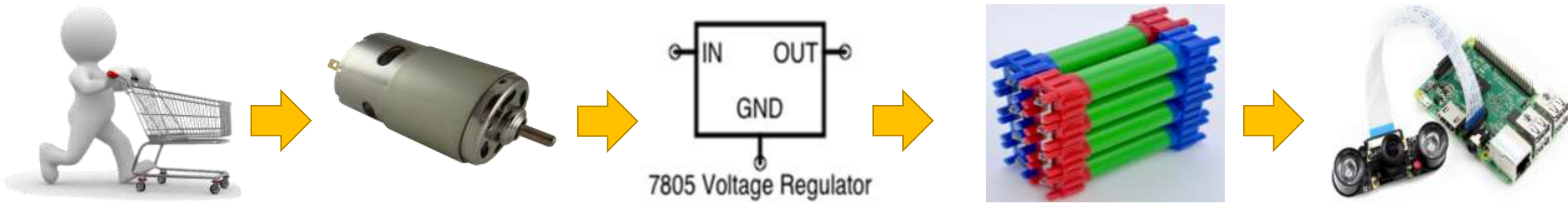
Smartphone
- Application
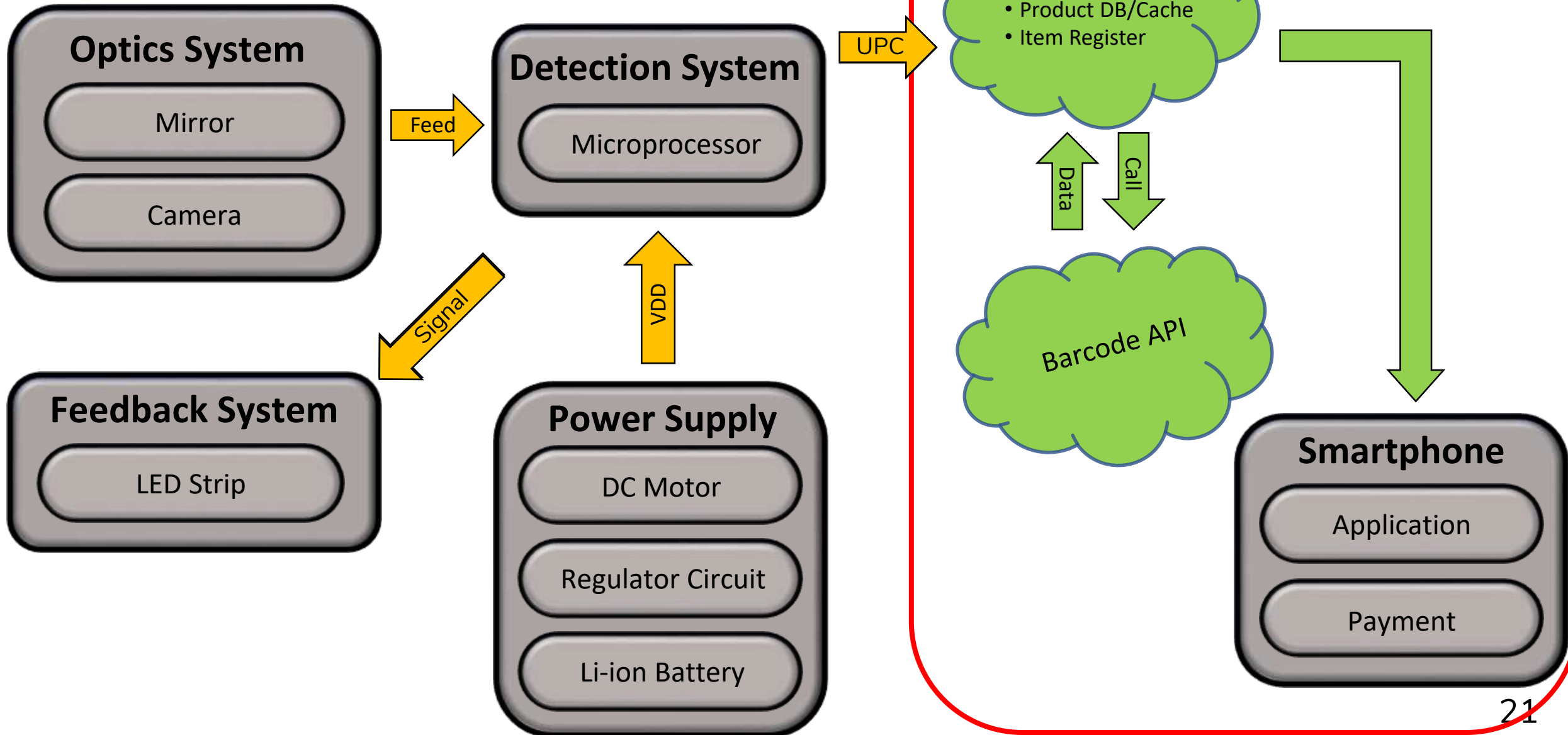- Payment

Signal

VDD

UPC

Data

Call

Power Supply

- Self-sufficient to avoid charging

- DC Motor to generate power mechanically

- Brushed DC Motors typically 75-80% efficient

- Regulator circuit to produce constant and stabilized voltage

7805 Voltage Regulator

Cloud Platform

Optics System
- Mirror
- Camera

Feed →

Detection System
- Microprocessor

UPC →

Cloud Database
- Product DB/Cache
- Item Register

Data ↑ | Call ↓

Barcode API

Feedback System
- LED Strip

Signal ↓

VDD ↑

Power Supply
- DC Motor
- Regulator Circuit
- Li-ion Battery

Smartphone
- Application
- Payment

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Cloud Platform

- Track orders with database

- Manage product information

  - Request from UPC API
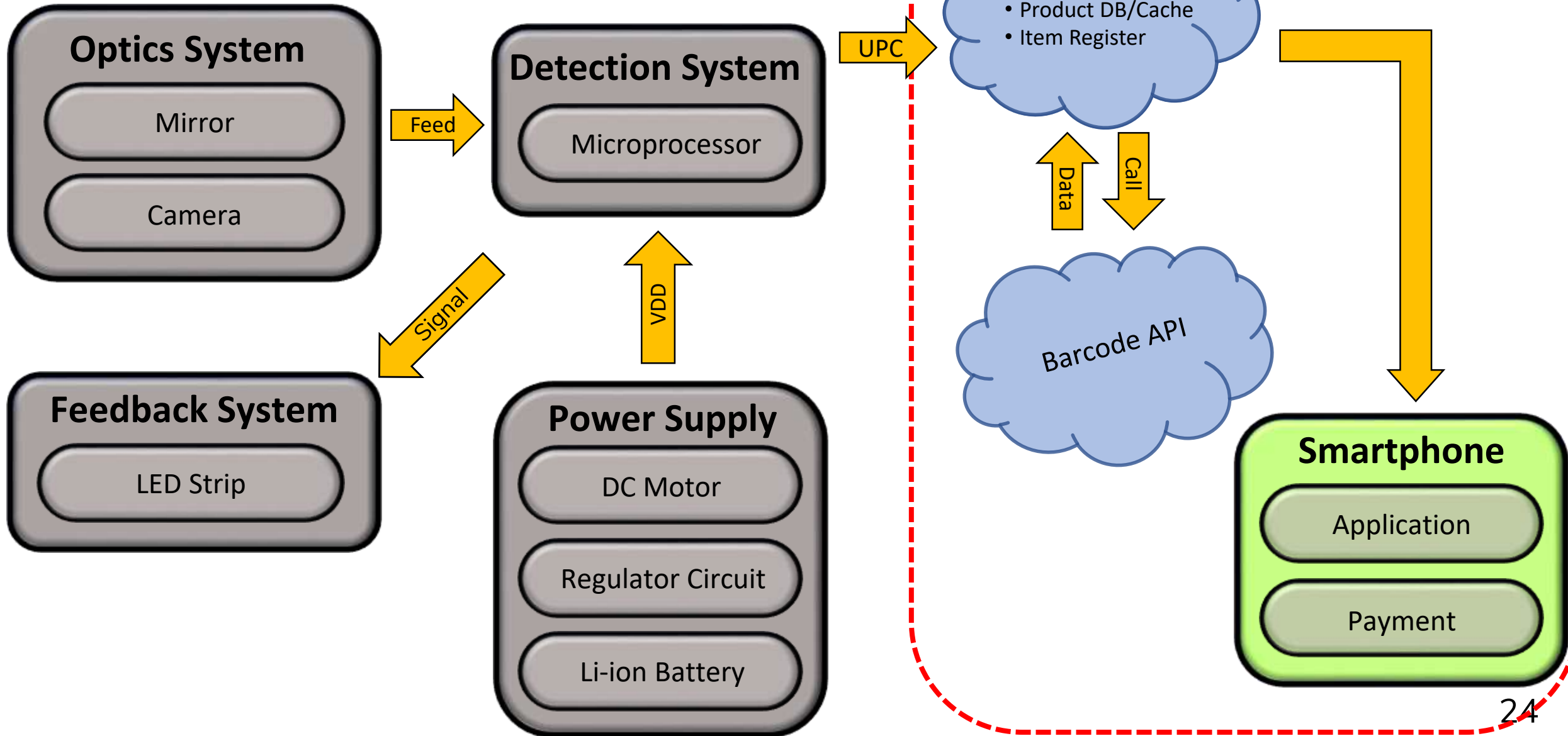
  - Cache results in local database

```
[~/barcode-api-poc] (master)
monoflo@sinc $ python3 lookup.py 073149169396
2018-10-16 18:56:51,389 [INFO] request="https://api.barcodelookup.com/v2/products?barcode=073149169396&geo=us&key=stdn3wd6a6c0mnxycvdkdssis853a3" status="200"
Product Name: Sterilite, File Crate, Black
Response:
{'products': [{'actor': '',
              'artist': '',
              'asin': '',
              'audience_rating': '',
              'author': '',
              'barcode_formats': 'UPC 073149169396, EAN 0073149169396',
              'barcode_number': '073149169396',
              'barcode_type': 'UPC',
              'brand': 'Sterilite',
              'category': 'Furniture > Cabinets & Storage > Storage Chests',
              'color': '',
              'description': 'Sterilite File Crate: Accommodates letter- and '
                            'legal-size hanging foldersStackableIntegrated '
                            'handles for easy transport.',
              'director': '',
              'features': [],
              'format': '',
              'genre': '',
              'height': '',
              'images': ['https://images.barcodelookup.com/3192/31924376-1.jpg'],
              'ingredients': '',
              'label': '',
              'length': '',
              'manufacturer': 'Sterilite Corporation',
              'model': '',
              'mpn': '0007314916939',
              'nutrition_facts': '',
              'package_quantity': '',
              'product_name': 'Sterilite, File Crate, Black',
              'publisher': '',
              'release_date': '',
              'reviews': [],
              'size': '',
              'stores': [{'currency_code': 'USD',
                         'currency_symbol': '$',
                         'product_url': 'http://www.walmart.com/ip/Sterilite-File-Crate-Black/11014785',
                         'store_name': 'Wal-Mart.com USA, LLC',
                         'store_price': '5.97'}],
              'studio': '',
              'title': '',
              'weight': '',
              'width': ''}]}
[~/barcode-api-poc] (master)
monoflo@sinc $
```
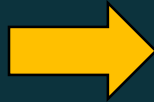
GET api.barcodelookup.com/{…} HTTP/1.1
Response:
   UPC: 073149169396
   Product: Sterilite File Crate
   Price: 5.97 USD

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User Interface

Optics System
- Mirror
- Camera

Detection System
- Microprocessor

Feedback System
- LED Strip

Power Supply
- DC Motor
- Regulator Circuit
- Li-ion Battery

Cloud Database
- Product DB/Cache
- Item Register

Barcode API

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Feed

Signal

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UPC

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User Interface

- Display item register, balance

- Enables a path to payment implementation

  - i.e. Samsung Pay, Venmo
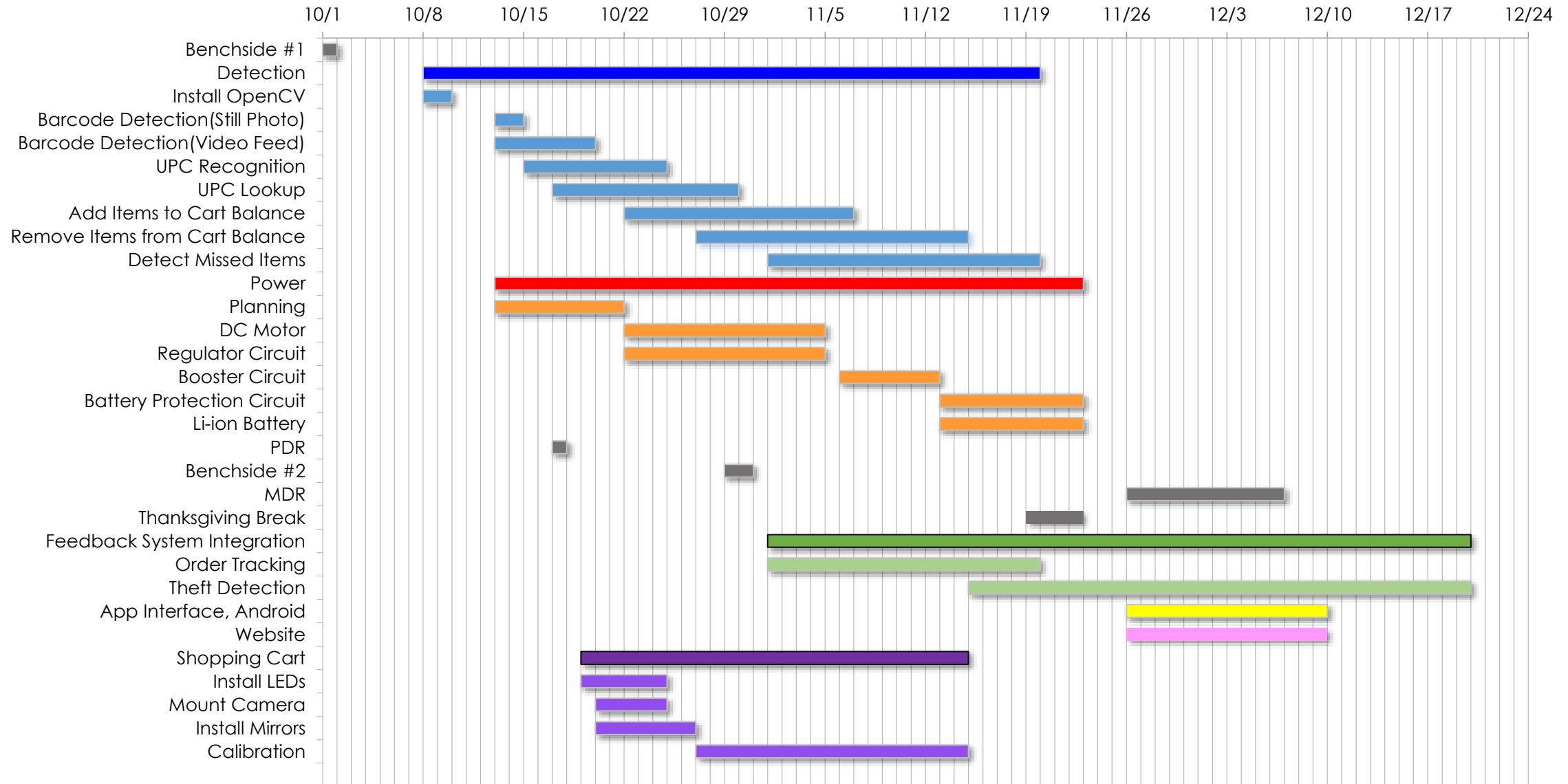
Bill of Materials

- ✓ Raspberry Pi

- ✓ Camera

- ✓ Intel Movidius Visual Compute Stick

- ✓ Android Phone

- ❑ Shopping Cart

- ❑ Mirrors

- ❑ DC Motor(s)

- ❑ VRUZEND Battery Kit

- ❑ Li-ion Battery Cells

- ❑ PCB

- ❑ RGB LED Strip

MDR Deliverables

- Detect barcode around 180° of camera perspective

- Successful integration of feedback system

- Update cloud database with product information

- Show power generation using DC Motor

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