IoT Driven Smart Bus Stops

Funded Research Project Proposal

○ Project Guides

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Waiting Indefinitely at Bus Stops...

The Problem

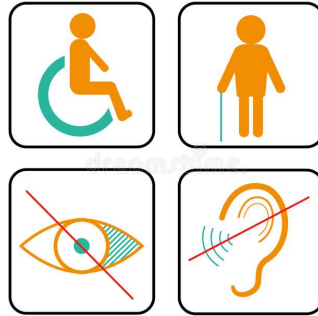### Indefinite Waiting

Commuters are kept in the dark.

Move back-and-forth to **read bus numbers**

Impractical Signage

Signage that **can't be read** from far.

Only in the **local language**

Worse for the Specially-Abled

Unpredictable systems keep them **dependent** on others.

Inaccurate Schedules

Seldom follow the prescribed schedule. Heavy **Traffic**.

Inefficient Existing Systems

Existing systems use **expensive** GPS

Not easily **adaptable**.

Proposed Solution

- An **Internet of Things** and **Machine Learning** based system to track, announce and predict schedule of buses.

- **Live tracking** of buses on a dedicated website.

- Using collected data to build a **predictive model** to provide a tentative schedule.
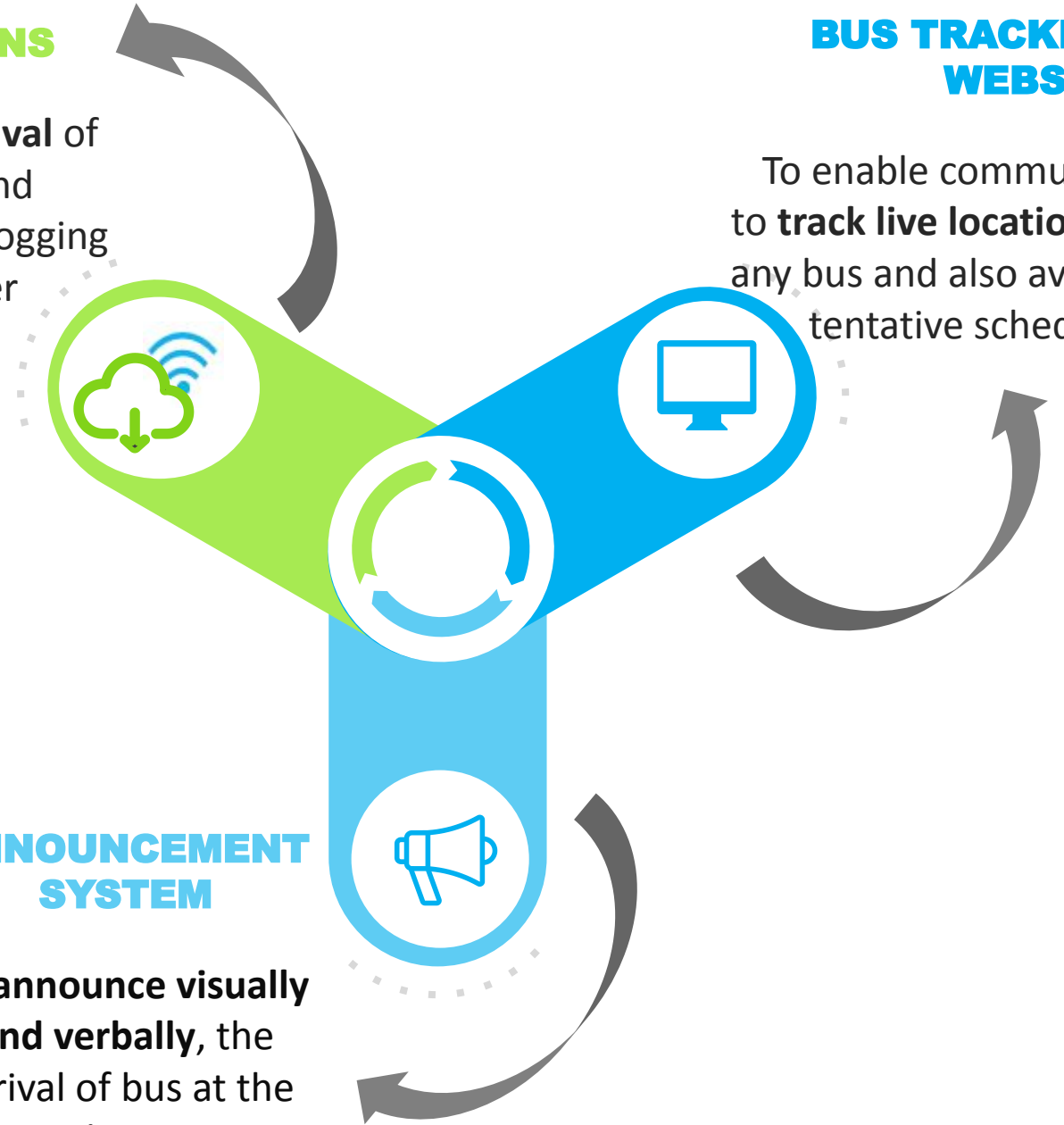
IoT BEACONS

To **detect arrival** of bus at stop and trigger data-logging on web-server

BUS TRACKING WEBSITE

To enable commuters to **track live location** of any bus and also avail a tentative schedule.

ANNOUNCEMENT SYSTEM

To **announce visually and verbally**, the arrival of bus at the previous stop
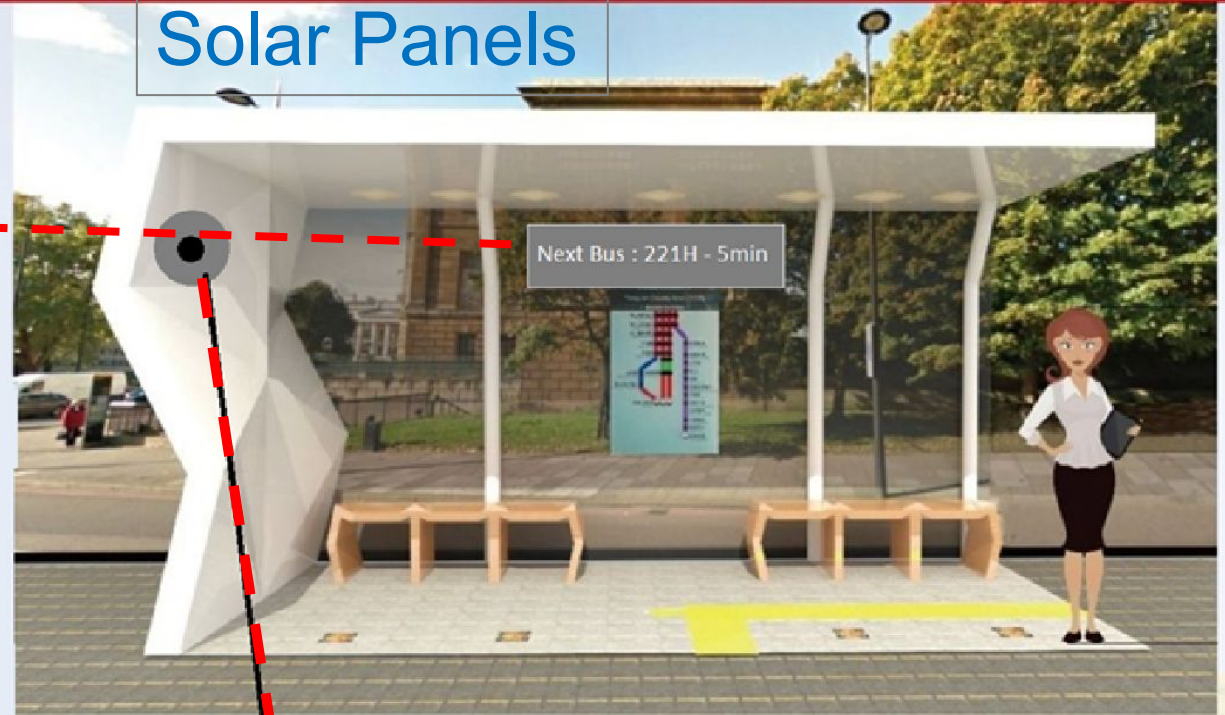
Smart Bus Stop

Solar Panels

Next Buses

221H	Central	3 mins
19B	T. Nagar	4 mins
102X	Broadway	7 mins

Announcement System

Next Bus : 221H - 5min

Beacon Sensing
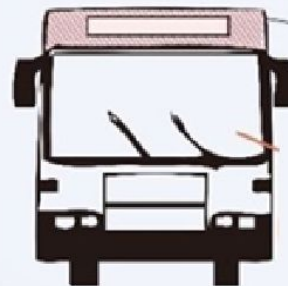
Database

Track live-location of any bus on the go

○ A predicted **tentative schedule** at your fingertips

○ **Plan** your commute accordingly

○ **Avoid waiting** at bus stops and save **time**

Why is this a Better Solution?

Proposed Solution

- Compatible Model
  - Can be **directly embedded** into existing buses and stops. **Easy to install** beacons and **portable** system

- Cost-effective
  - Low-cost **Radio-Frequency** transmitters and receivers

- Schedule Prediction and Announcement
  - Using collected data and traffic statistics to predict a **tentative schedule** and announce arrival of buses

Existing and Other Systems

- Heavy on Installation Time and Cost
  - Many of the proposed systems require **significant modification** of buses/stops to be installed

- Expensive
  - Usage of expensive **GPS** modules
  - **Close-spacing** of bus stops eliminates need for GPS

- Inexistence of such Models
  - Most announcement systems are **manual**, limited to major termini
  - Absence of live-tracking for city buses

Advantages & Future Extensions

Other Advantages

- **Specially-abled** people can simply listen to the announcements

- **Automatically report** buses that do not stop, to the city corporation

- Better **accuracy** compared to GPS modules

- Not susceptible to **relocation** of bus-stops

- **Announcements** are made one-stop in advance, in **English** for the benefit of outsiders
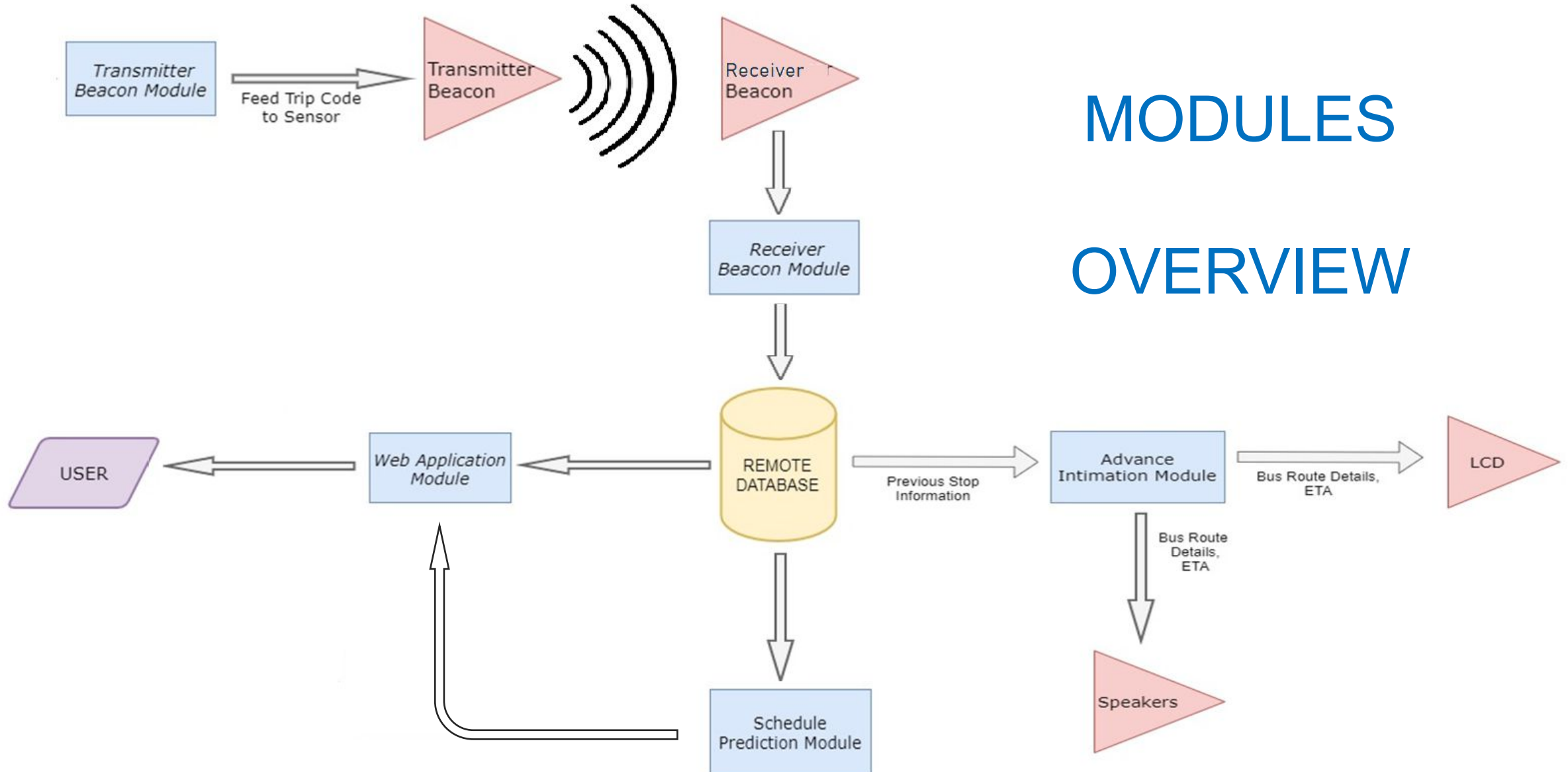
Adaptability

- Can use **solar panels** to power the device at bus-stops

- With larger panels, **charging spots** and **water-filters** can be set up

- For **real-scale** implementation, **microwave transmitter** can be used

- Translations can be made to **include local language** also, through simple software changes

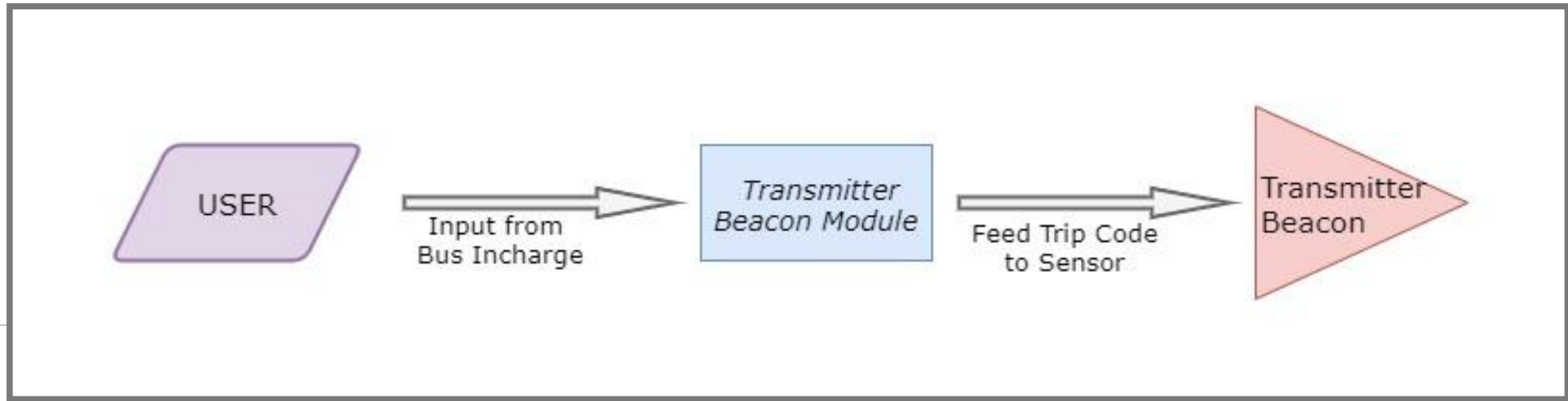- Microcontrollers and web-access can **support future applications**

MODULES

OVERVIEW

Implementation Architecture

Module-Wise Task Allocation – TRANSMITTER MODULE

USER → Input from Bus Incharge → Transmitter Beacon Module → Feed Trip Code to Sensor → Transmitter Beacon
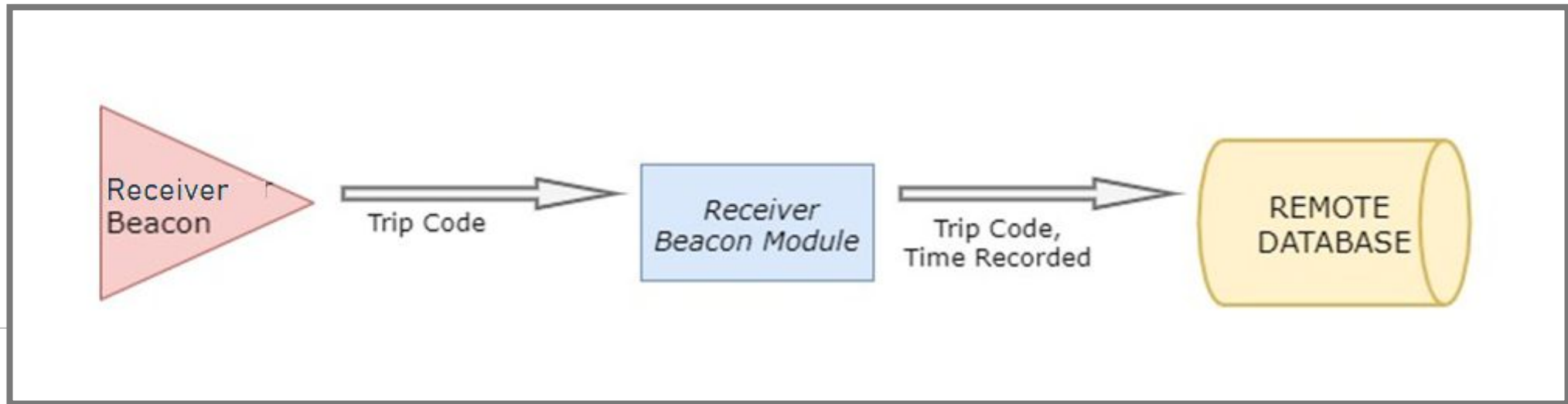
Functionality

- Accept trip details from bus in-charge
- Periodically transmit trip details

Key Hardware Used

- Arduino Microcontrollers
- RF Transmitter
- Input device for in-charge

Implementation Architecture

Module-Wise Task Allocation – RECEIVER MODULE

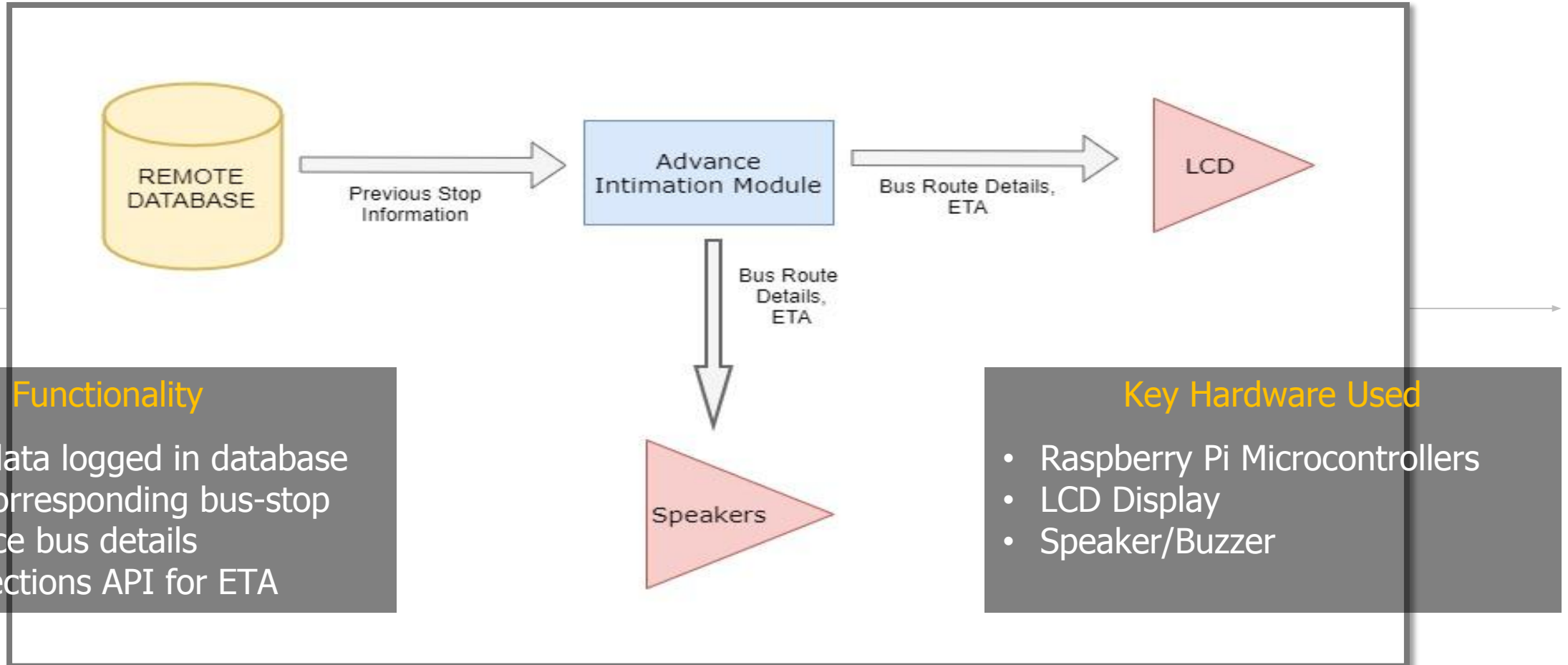| Functionality	Key Hardware Used
• Detect arrival of bus • Identify trip details • Register timestamp in Database	• Raspberry Pi Microcontrollers • Arduino Microcontrollers • RF Transmitter • RF Receiver

Implementation Architecture

Module-Wise Task Allocation – INTIMATION MODULE

Functionality

- Detect data logged in database
- Notify corresponding bus-stop
- Announce bus details
- Use Directions API for ETA

Key Hardware Used

- Raspberry Pi Microcontrollers
- LCD Display
- Speaker/Buzzer

Implementation Architecture

Module-Wise Task Allocation – WEB-APPLICATION MODULE
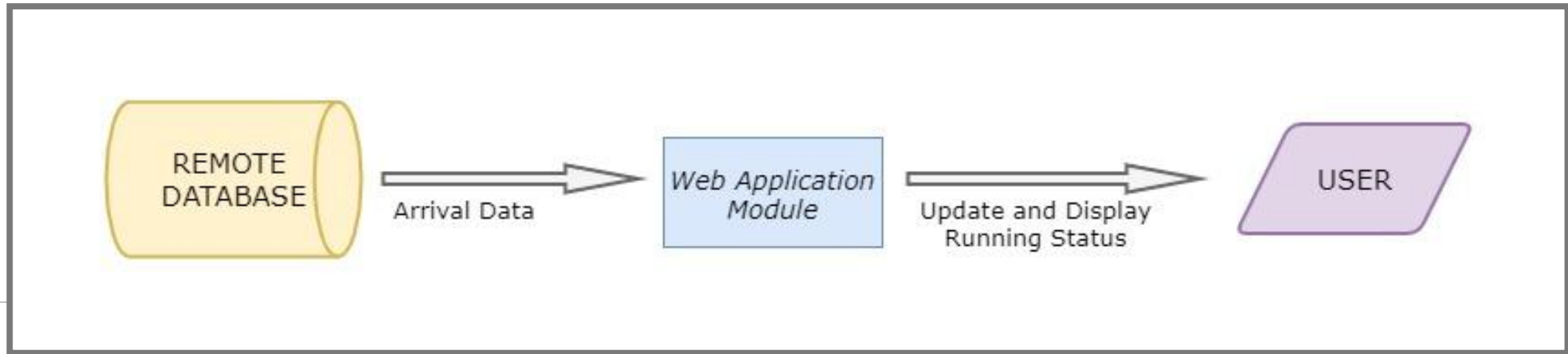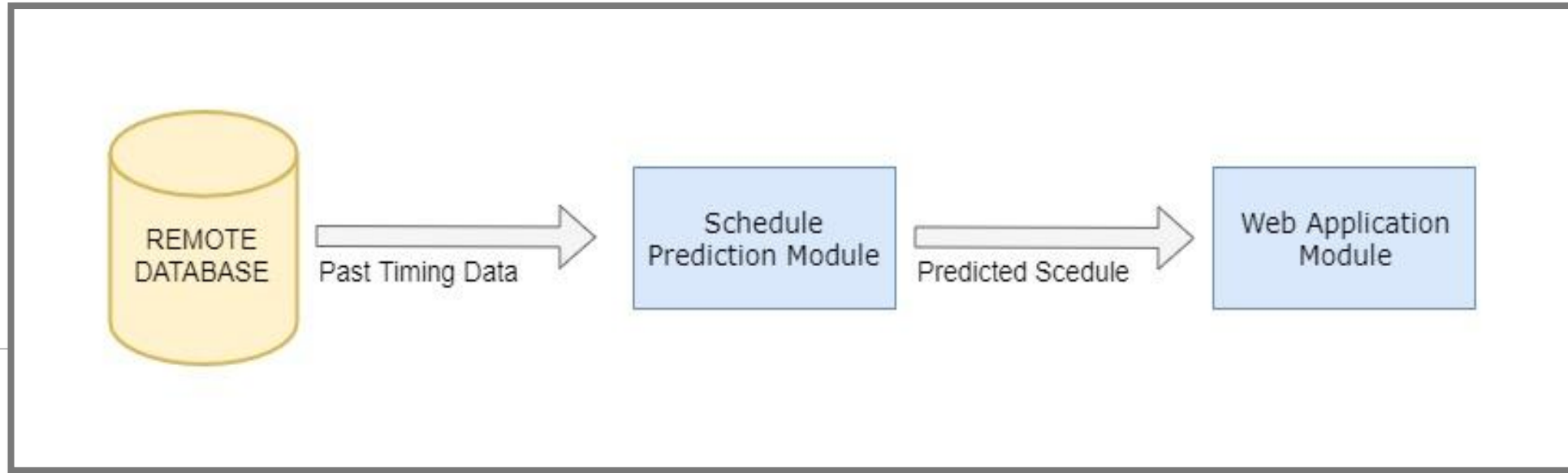

Functionality

- Access bus data from database
- Provide an user-friendly interface
- Display live-location to end user

Key Hardware Used

- Raspberry Pi Microcontrollers
- User's output device

Implementation Architecture

Module-Wise Task Allocation – SCHEDULE PREDICTION MODULE

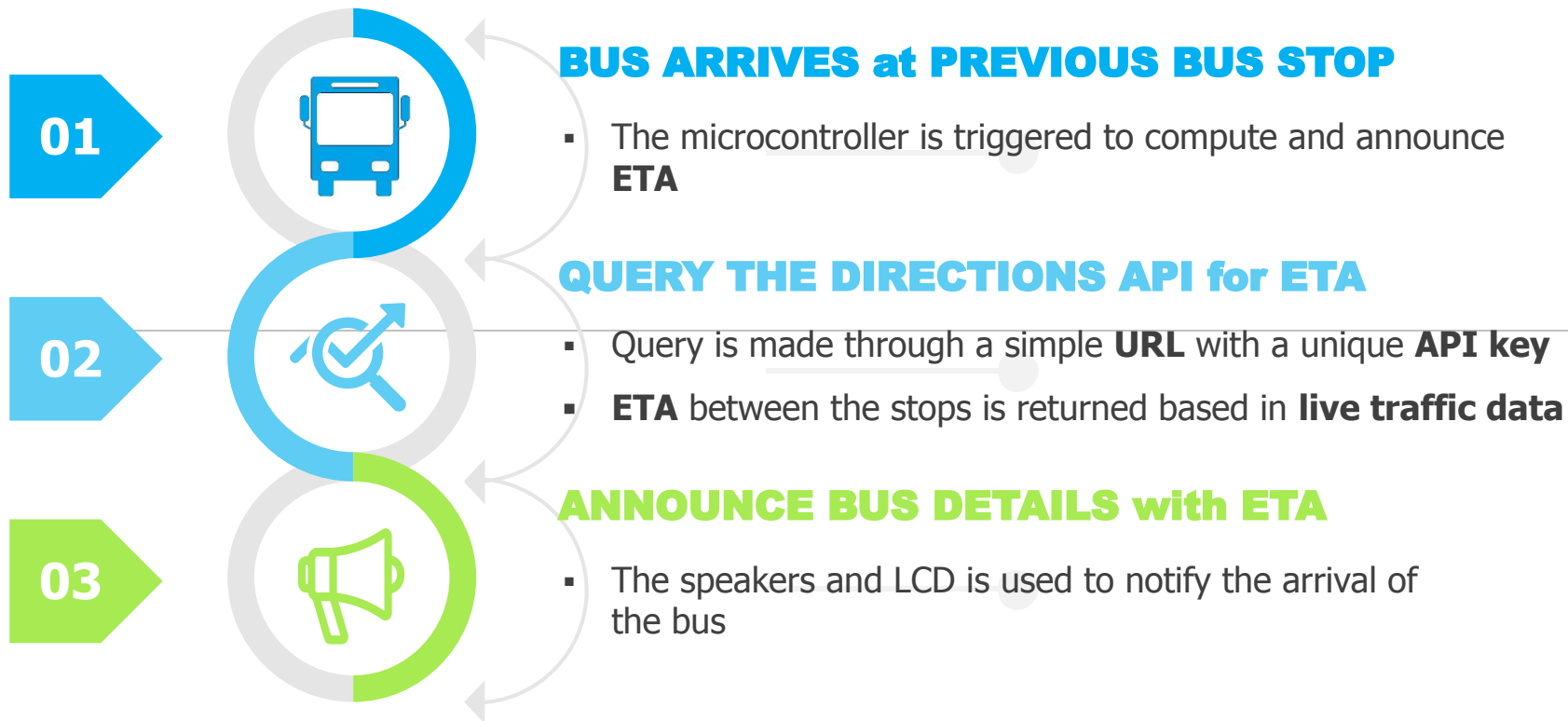| Functionality	Key Hardware Used
• Access past bus data • Analyze data patterns • Predict a tentative schedule	• Raspberry Pi Microcontrollers • GPU for training the model

Querying the Directions API

BUS ARRIVES at PREVIOUS BUS STOP

01

- The microcontroller is triggered to compute and announce **ETA**

QUERY THE DIRECTIONS API for ETA

02

- Query is made through a simple **URL** with a unique **API key**
- **ETA** between the stops is returned based in **live traffic data**

ANNOUNCE BUS DETAILS with ETA

03

- The speakers and LCD is used to notify the arrival of the bus

○ The Directions API is used to give an **ETA** of the bus after it has **reached the previous bus stop**

○ More suitable and **effective** for considering **live traffic status**.

○ The **ML based prediction** is used only for a **tentative schedule** on the website based on past data.

Project Deliverables

MACHINE LEARNING MODEL

A predictive model to use **past bus arrival data** at stops to forecast a tentative schedule

IoT BEACON and ANNOUNCEMENT SETUP

The IoT system to both **detect bus arrival** and announce **ETA** at the subsequent stop.
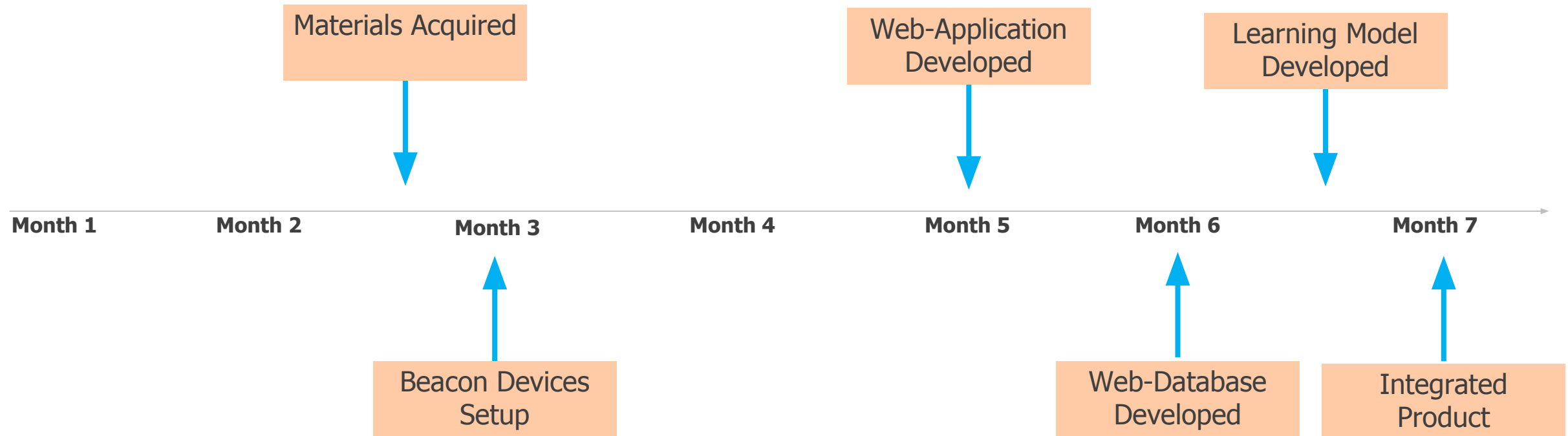
WEB APPLICATION

An output node to provide **live bus tracking** along with the predicted schedule to the end user

MINIATURE SIMULATION MODEL – 2 STOPS

A composite miniature model to simulate the functioning on a small scale

Tentative Timeline

Project Action Plan – Completion of Milestones

Materials Acquired

Web-Application Developed

Learning Model Developed

Month 1　　Month 2　　Month 3　　Month 4　　Month 5　　Month 6　　Month 7

Beacon Devices Setup

Web-Database Developed

Integrated Product

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Thank You