

Implementation of Multimodal Tracking Capabilities for High-Altitude Ballooning

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Outline

- Introduction
- Overview of the System
- Implementation Details
 - ❖ RF-based tracking
 - ❖ Cellphone-based tracking
 - ❖ Mobile station
- Concluding Remarks



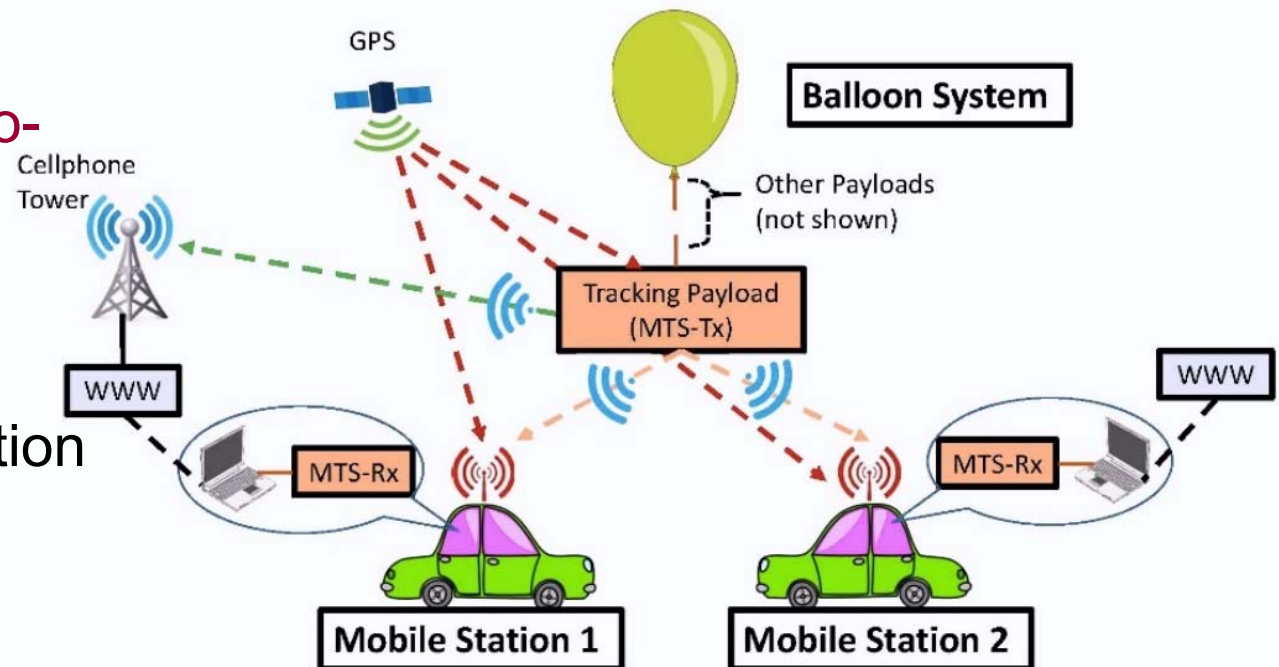
Introduction

- Common balloon tracking methods
 - ❖ Satellite-based (~1.6 GHz for users)
 - ❖ Automatic Packet Reporting System (APRS)-based (~144 MHz)
 - ❖ Cellphone (~2 GHz)
 - ❖ Radio frequency (RF)-based (~900 MHz)
- Gannon's multi-modal tracking payload
 - ❖ Integration of multiple methods into one payload
 - ❖ Cellphone + RF-based (+ APRS-based)
 - ❖ In compliance to FCC regulations for cellphone-based



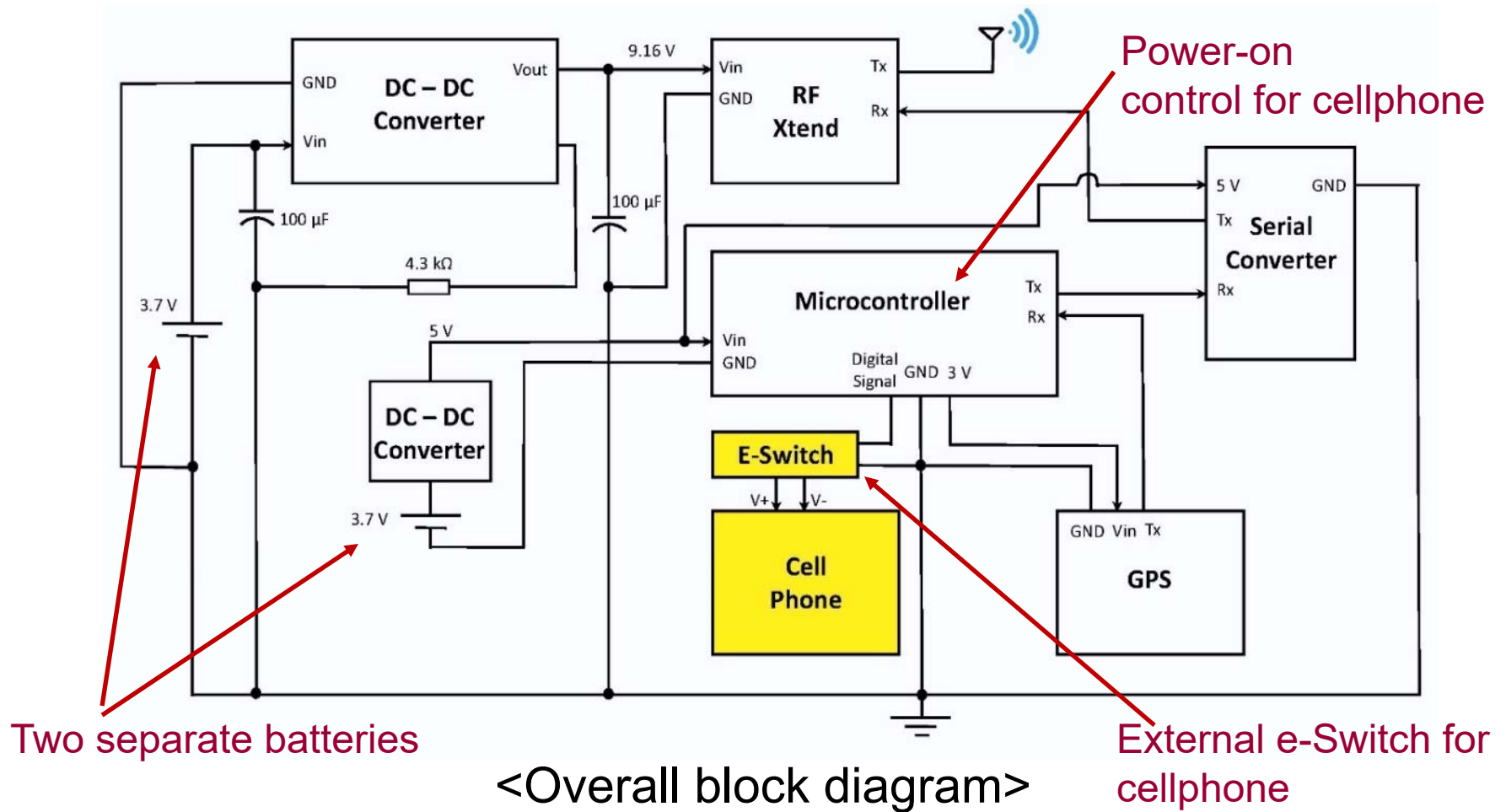
Multimodal Tracking System (MTS)

- Tracking payload
 - ❖ RF-based, point-to-multipoint
 - Line-of-sight
 - ❖ Cellphone-based
 - Online application
- Mobile stations
 - ❖ Support multiple vehicles





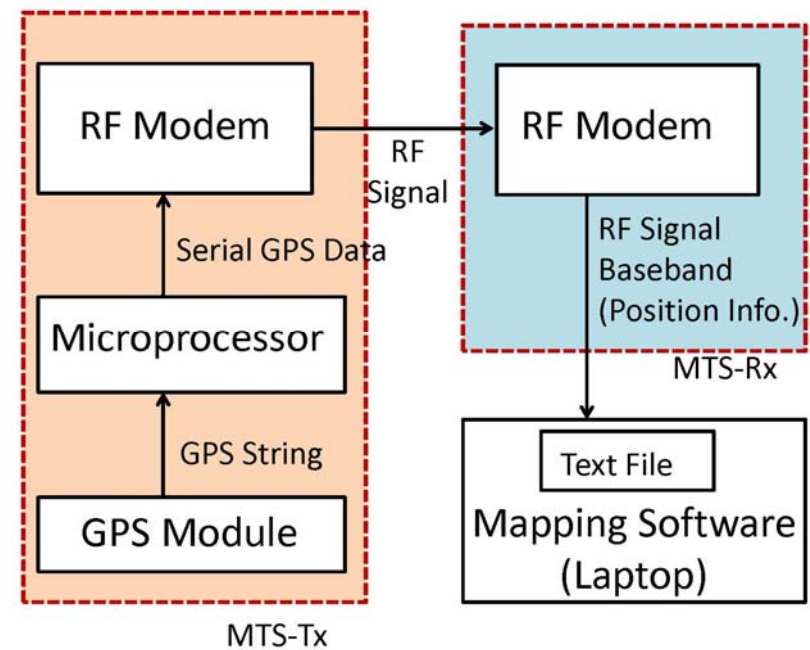
Implementation: Payload





Implementation: RF-based

- Used XTend 900 MHz RF radios
- Microcontroller: 4800 baud rate
- USB driver in C#: to save coordinates into a CSV file
- Mapping by MapPoint 2013

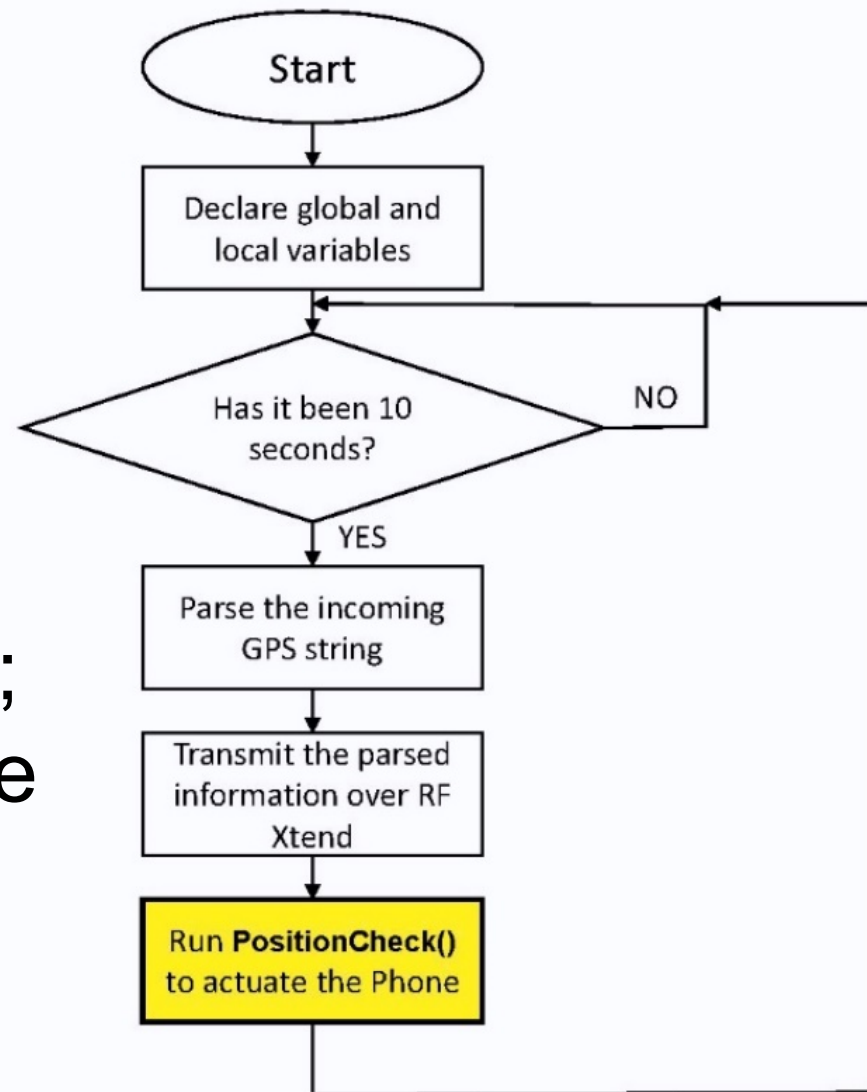


Functional diagram of the RF-based tracking



Microcontroller: Processing

- Overall flow chart for the operation →
- Position updates every 10 seconds
- Initially for RF-based; enhanced to integrate cellphone-based



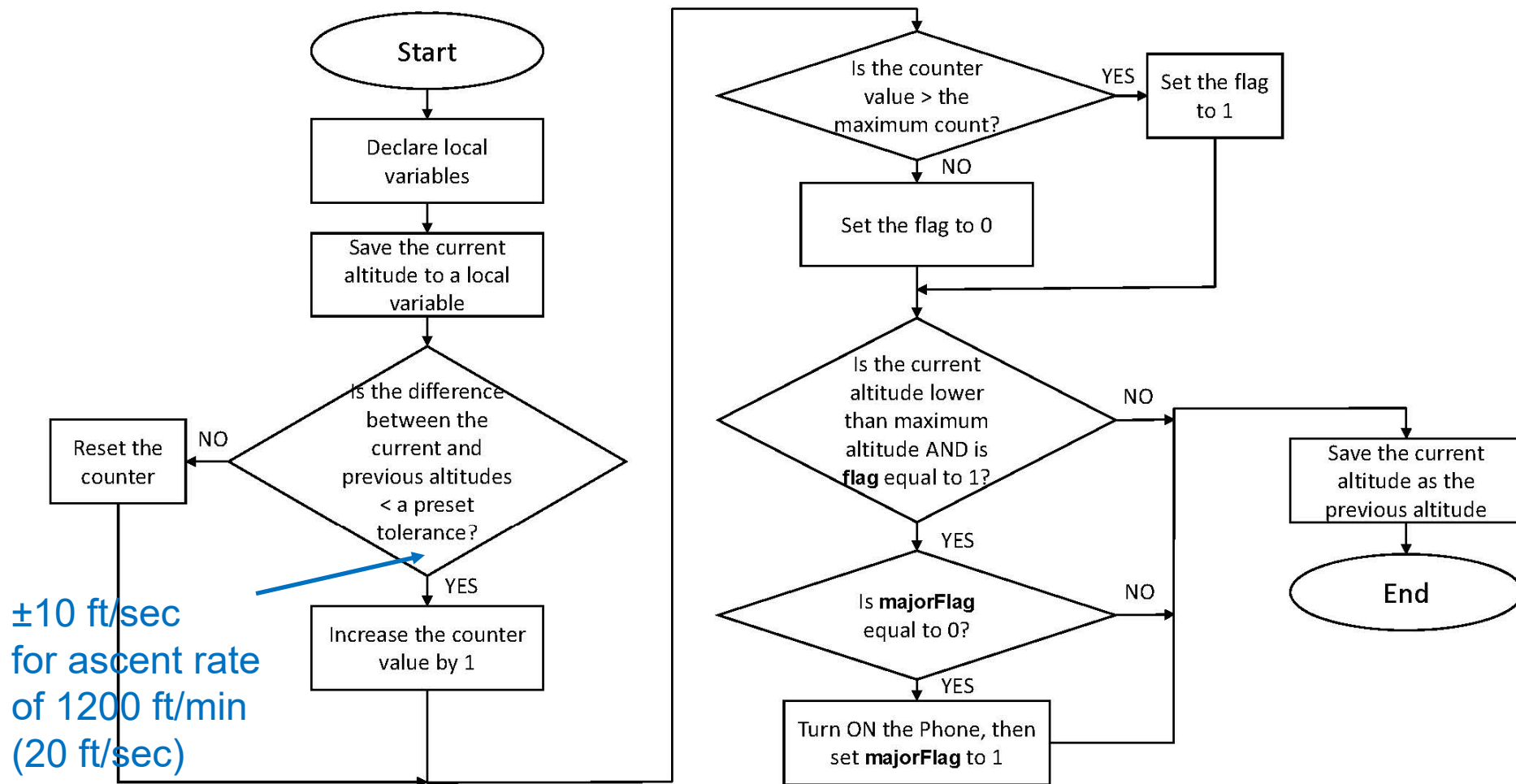


Implementation: Cellphone-based

- GPS enabled smartphone
- Mapping by an online application
- FCC regulation 22.925
 - “Prohibition on airborne operation of cellular telephones”
- ➔ Microcontroller code to detect if the payload has landed
- ➔ Design of an electronic switch for Power-ON



PositionCheck()





Mobile station

➤ Antenna module

- ❖ 3-element or 7-element Yagi antennas
- ❖ XTend RF radio (USB connector) + cigarette charger cable
- ❖ Standalone GPS receiver

➤ Laptop

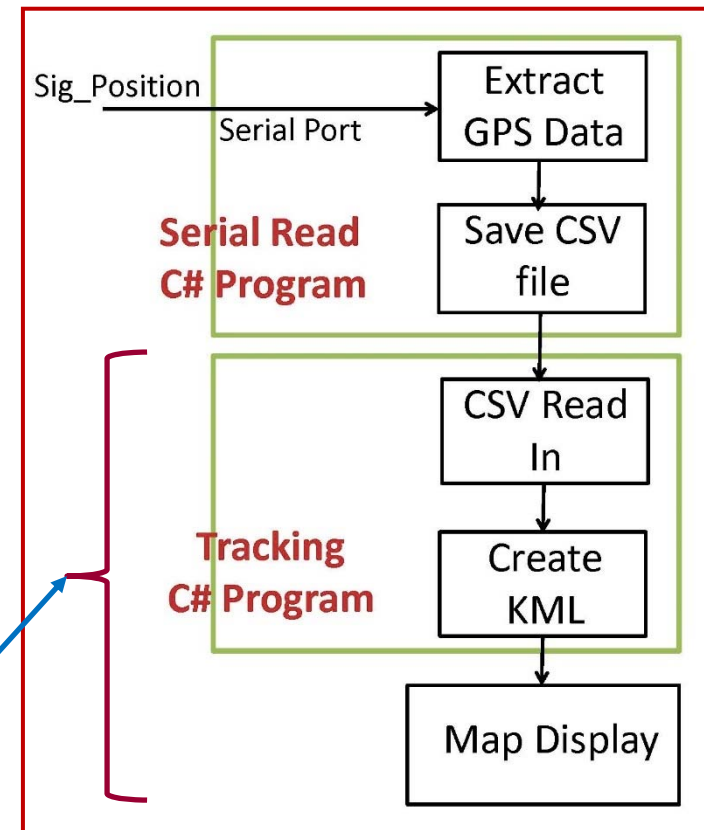
- ❖ Mapping software (Google Earth-based or MapPoint)
- ❖ Mobile hotspot (for access to the Internet, if necessary)



Mapping Software

- Initially, Google Earth-based mapping software (in-house)
 - ❖ Read position coordinates from the USB port(s)
 - ❖ Software development in C# (new programming language to ECE students)

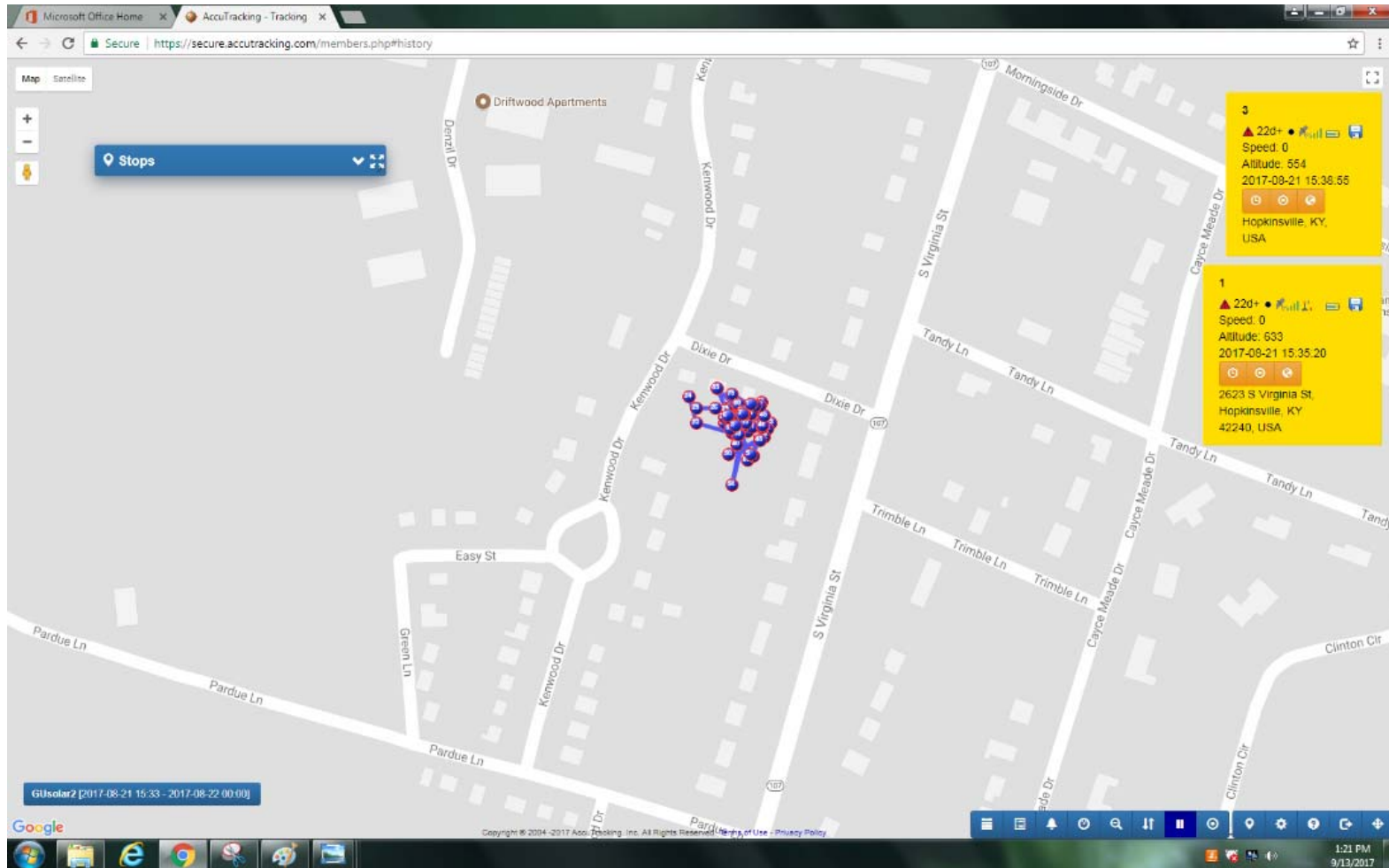
Replaced by MapPoint



Block diagram of the mapping software



Mapping Example



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Concluding Remarks

- Presented a multi-modal tracking system (MTS) intended to enhance balloon tracking capabilities
- Built as an additional payload to a baseline ballooning platform for the 2017 solar eclipse ballooning



Q & A