

Implementation of Simultaneous Multi-Streaming of Live Solar Eclipse Video via 5.8 GHz AirMax

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Outline

- Introduction
- Overview of the system
- Approach to video streaming
 - ❖ two cameras
 - ❖ two+ cameras
- Configuration and testing
- Concluding Remarks



Introduction

➤ Video streaming for the 2017 solar eclipse

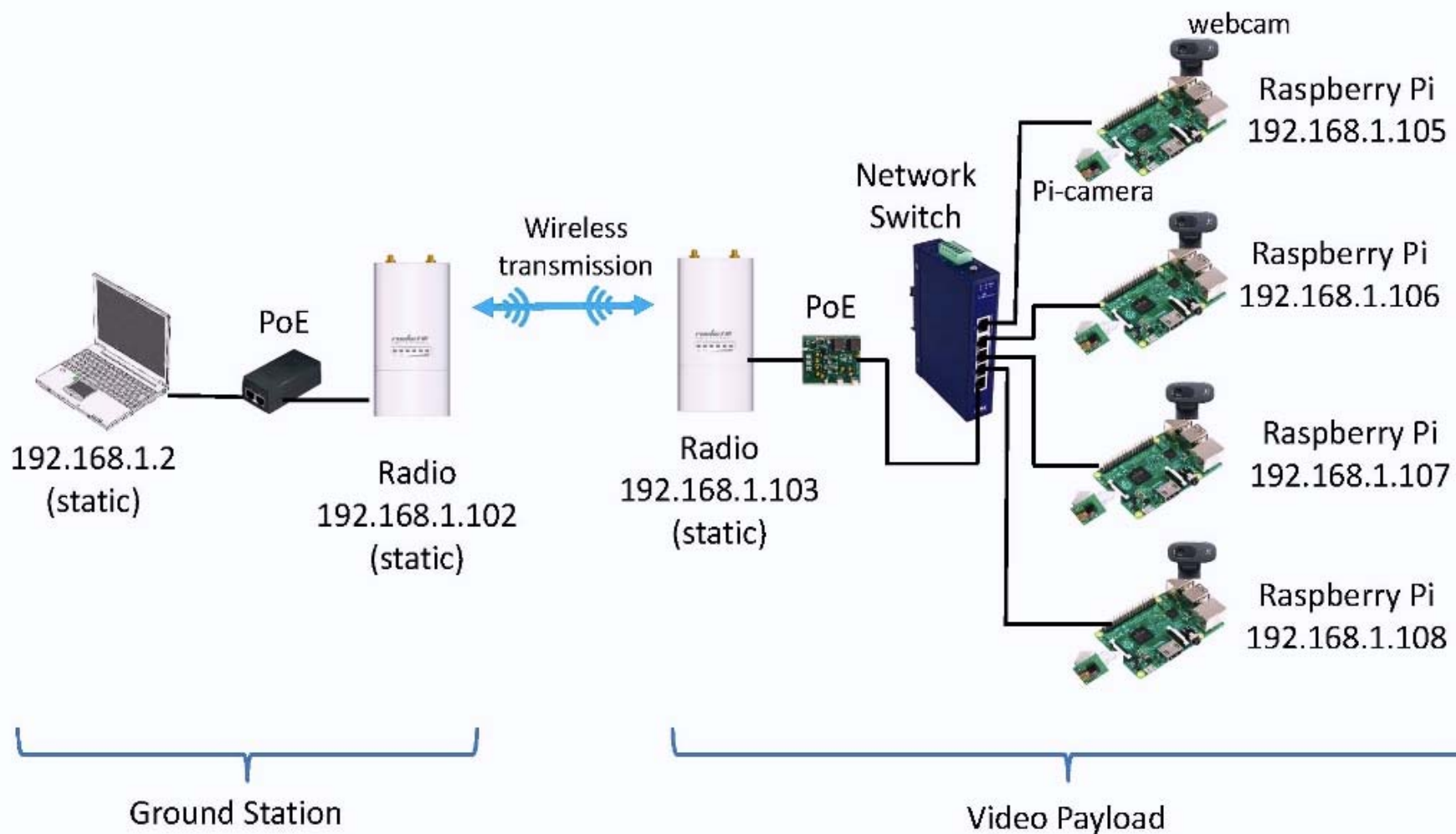
- ❖ To send live video from near space to a designated website (<https://eclipse2017.nasa.gov/eclipse-live-stream>)

➤ Challenges

- ❖ Only one camera, one Raspberry Pi in the baseline system
- ❖ Desire to capture video from more than one direction
 - Pi-camera on a servo motor on top of the video payload
 - Multiple Pi-cameras & a multiplexor board
 - Multiple Raspberry Pi boards, each with a Pi-camera, and multiple M5 modems (one per Raspberry-Pi)
- ❖ Simultaneous streaming of all videos



Our Approach: System Overview





System Overview (2)

➤ Key enablers of our video streaming system

- ❖ Four Raspberry-Pi's (2017 solar eclipse ballooning)
 - ❖ Two cameras per Raspberry-Pi
 - One Pi-camera (streaming), one webcam (storage)
 - ❖ High-speed Ethernet switch: multiplexing of all video traffic
 - ❖ Optimization of video traffic for specific transmission rate of M5 modem
 - ❖ Use of OBS to feed multi-window streaming to online site
- ➔ Potentially, could support more simultaneous video streams $\sim 2^{\{\# \text{ of Raspberry-Pi's}\}}$, desired transmission range



Streaming w/ Two Cameras

➤ One Raspberry-Pi with Two Cameras

❖ Default Pi-camera slot for a Pi-camera

- Video coding: H.264
- See Fig. 3 (in the paper) for steps – relatively simple

❖ USB ports (4): good for webcams → 1 webcam used

- Video coding: Motion-JPEG (MJPEG) – simpler to set up than H.264
- Motion Service for automatic streaming at boot-up

<http://www.instructables.com/id/How-to-Make-Raspberry-Pi-Webcam-Server-and-Stream-/>

- See Fig. 2 (in the paper) for steps



Streaming w/ Two+ Cameras

- Multiple (4) Raspberry-Pi's, each with a Pi-camera for streaming, and an Ethernet switch
 - ❖ CPU usage of webcam on Raspberry Pi (← drawback)
 - ❖ Optimize resolution, framerate, and bitrate
- M5 Modem Transmission Capacity
 - ❖ Tx/Rx data rates, Tx power and Rx sensitivity – available on datasheet
 - ❖ Range estimation with an our own empirical model (known info: 20 miles with M5 on the baseline system)
- High Bit-Rate Network Switch
 - ❖ 10/100/1000 Base-T Ethernet ports/ operating temperature



Key Parameters

➤ Pi-camera

stream.sh for the standard video payload

- resolution = 1920 x 1080
- framerate = 25 ~ 30 (p-frame)
- bitrate = 2,000,000 bps

stream.sh for our optimized video

- resolution = 640 x 380
- framerate = 15 (i-frame)
- bitrate = 500000

➤ M5:

- ❖ Set to MCS-5 (max. ~4.9 Mbps, estimated range: 20 miles)

Note:

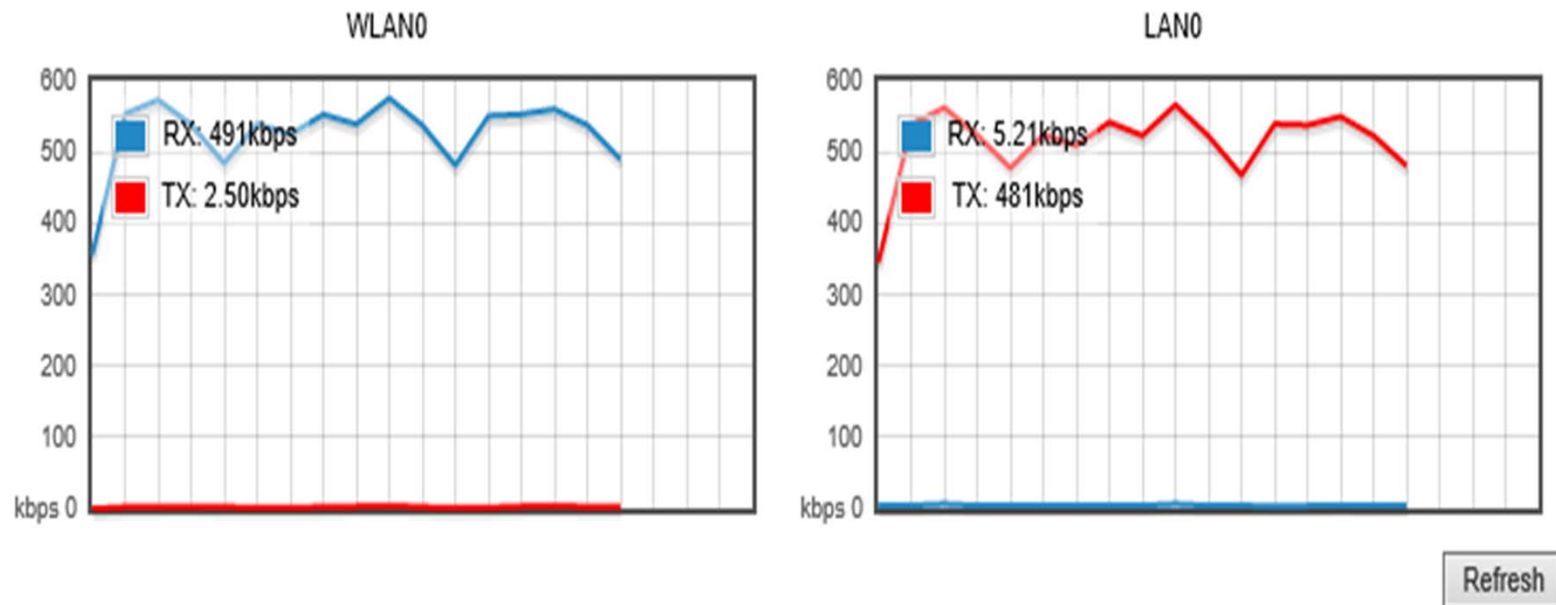
- ❖ M2 MCS-15 offers 270/300 Mbps, range TBD



Testing of M5 - Examples

Monitor

[Throughput](#) | [Stations](#) | [Interfaces](#) | [DHCP Client](#) | [ARP Table](#) | [Bridge Table](#) | [Routes](#) | [Log](#)



(a) Receiving data rate, 491 kbps

(b) Transmitting data rate, 481 kbps

Fig. 6 Receive and transmit data rates for streaming video from four Pi-cameras



Screenshot of four simultaneous streaming during the Aug. 21, 2017 flight





Conclusion

- Simultaneous multiple video streaming:
 - ❖ Four Pi-cameras
 - ❖ One Ethernet switch
 - ❖ One M5 for a 5.8 GHz wireless link
- Our approach is new to the HAB community (or anyone else has done it?)



Q & A