ATAK Low Latency Camera Platform (ALLCaP)

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Contents

Introduction

The ATAK Low Latency Camera Platform (ALLCaP) is a proof of concept that provides near real-time video display. The viewing device is an ATAK enabled tablet or phone while the video source is a USB-based camera or another ATAK enabled device.

Background

The ALLCaP project emerged from a previous effort to develop a low cost point-of-view (POV) system for canines and their handlers. The concept is to mount a camera on a dog so the handler may observe the dog's field of view. A speaker is also attached to the canine so the handler may issue verbal commands from a remote location. Both devices are connected to a radio that provides an IP connection to another radio that is connected to the handler's tablet or smartphone.

During the development of the K9 system, a few unforeseen factors emerged as critical design concerns. First, the latency of the video stream is critical for this type of use. The delay should be less than 500 milliseconds in order to effectively control the dog. Popular video display applications proved to be too slow and unreliable. The second major consideration was the camera selection criteria which included not only the camera's performance specifications but it's connection mechanism. Some cameras that were reviewed required additional hardware like encoders to work over the IP connection or adapters in order to connect to the radio.

Problem Domain

Once the proof of concept for the K9 system was completed, another project was started with the goal of creating a robust camera/viewer platform. Ideally, this new platform could be used for the K9 scenario in additional to other use cases.

The major objectives and constraints for this project include:

- ***Low latency*** – The delay from the camera to the viewer must be less than 500 milliseconds using the radios.
- ***USB camera support*** – To leverage the widest range of available cameras, USB-based cameras must be supported.
- ***Low cost*** – The cost target of the software and hardware is $500 USD. This does not include the price of the radios or tablet/smartphones.
- ***IP connection*** – The connection between the viewer device and the camera compute device must be IP based.
- ***Device to device configuration*** – No reliance on intermediary or discovery servers.
- ***Available hardware*** – The components had to be Commercial Off The Shelf (COTS) units that are readily available. Custom made hardware would not be considered.

Solution Domain

The first step in the transition to the solution domain was the selection of the ATAK software. The Android Team Awareness Kit (ATAK) is a geospatial infrastructure and military situation awareness software platform. Since most of the operators have an ATAK-enabled device or are able to obtain one, the ATAK package provides the client environment for the ALLCaP viewer software.

Once ATAK was selected, three different camera architectures were created. These alternatives offer different features that can be leveraged by the user.

- *ATAK to ATAK (with built-in camera)*
- *ATAK with USB Camera (UV4L)*
- *ATAK with multiple USB Cameras (webrtc-streamer)*

ATAK to ATAK (with built-in camera)

This solution uses two Android devices and their built-in cameras. One user can stream video from the built-in camera of another user's Android device and vice-versa. This architecture works over any IP connection like Wi-Fi or radio as shown below:

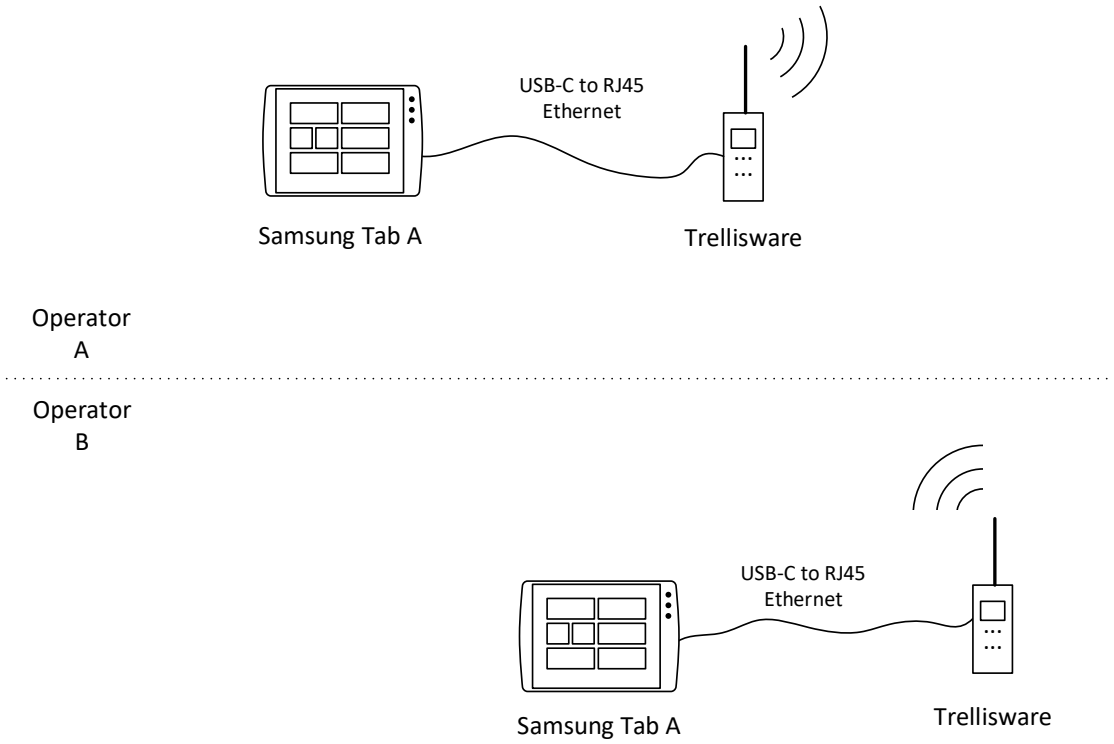

Figure 1 - ATAK to ATAK hardware architecture

The software architecture for the ATAK to ATAK configuration is shown below:

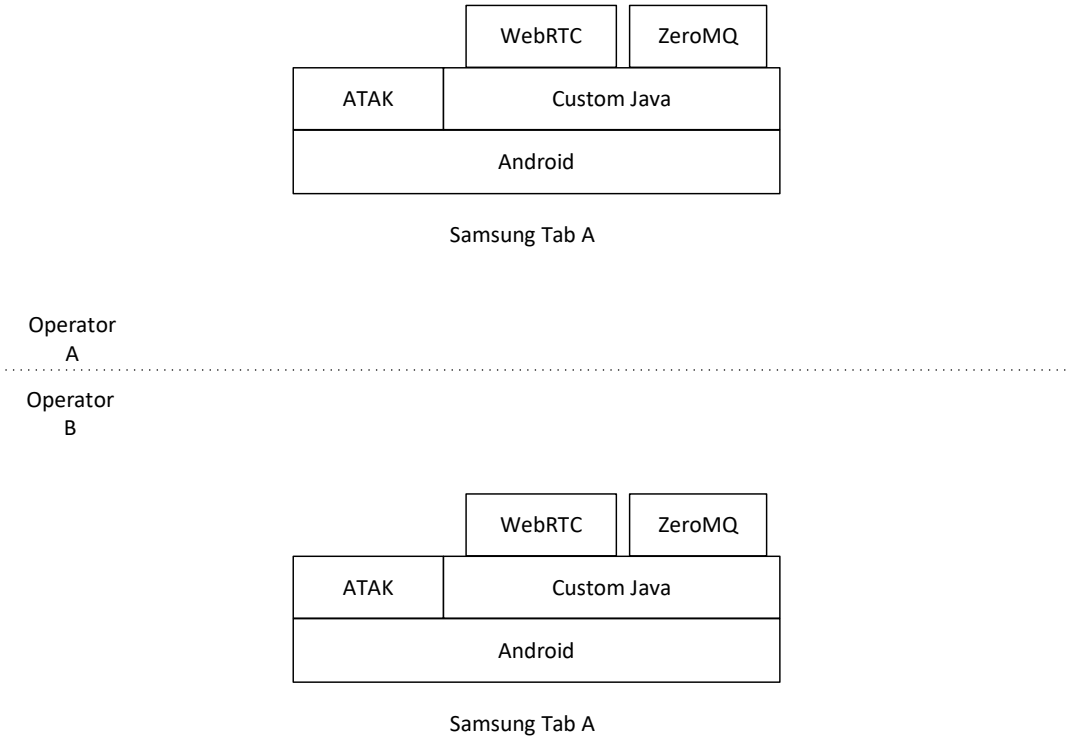

Figure 2 - ATAK to ATAK software architecture

The components of the software architecture include:

- ***WebRTC*** – This is an open source framework that enables Real-Time Communications (RTC).
- ***ZeroMQ*** – This is an open source framework that provides networking and messaging capabilities.
- ***ATAK*** – This is a government source framework that serves as an environment for the ALLCaP software.
- ***Custom Java*** – This is the custom Java application that allows the user to connect to and interact with a remote ATAK device.
- ***Android*** – An operating system for mobile devices.

ATAK with USB Camera (UV4L)

This solution provides streaming video from a remote USB-based camera. This architecture works over any IP connection like Wi-Fi or radio. The USB camera is connected to a Raspberry Pi (RPi) single board computer. The RPI is connected to an IP provider via Wi-Fi or an ethernet cable. The user can also send audio from a local microphone to a speaker attached to the remote device. The hardware architecture is shown below:

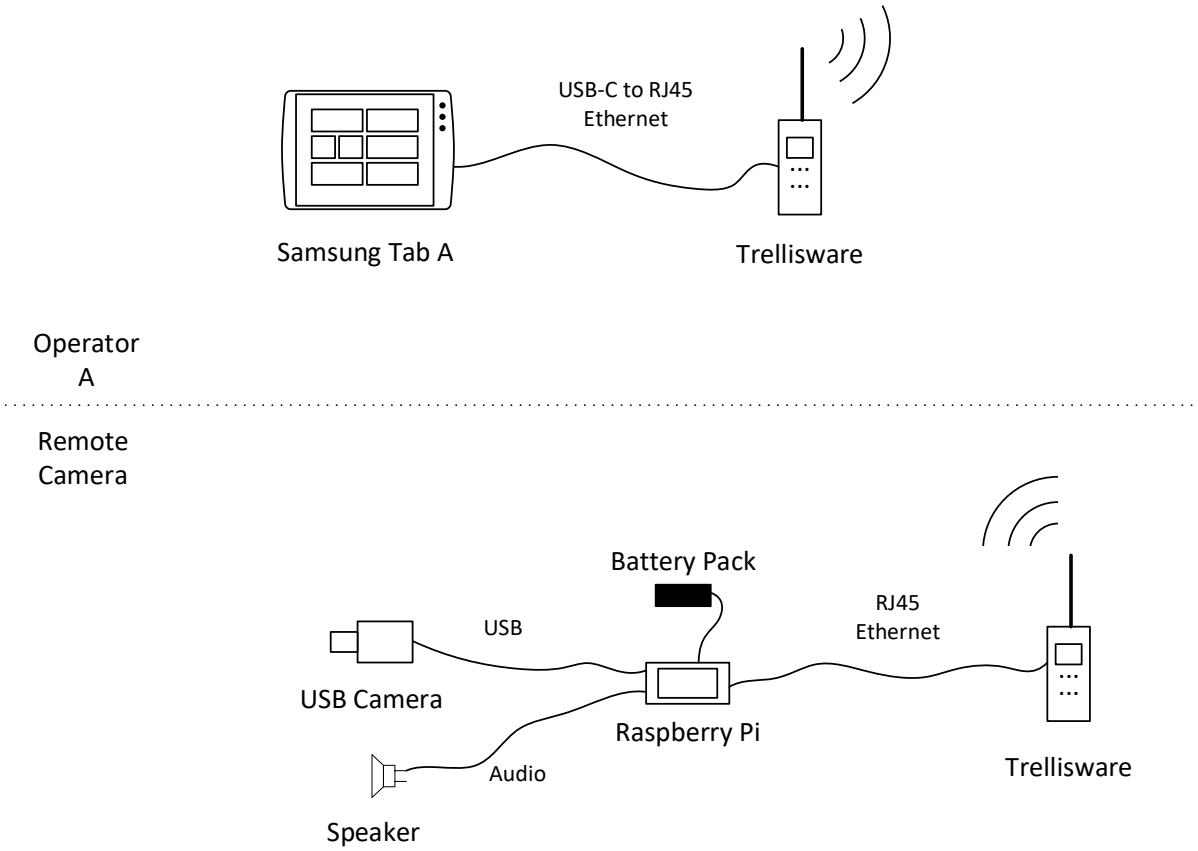

Figure 3 - ATAK to USB camera (U4VL) hardware architecture

The software architecture for the ATAK to USB camera (U4VL) configuration is shown below:

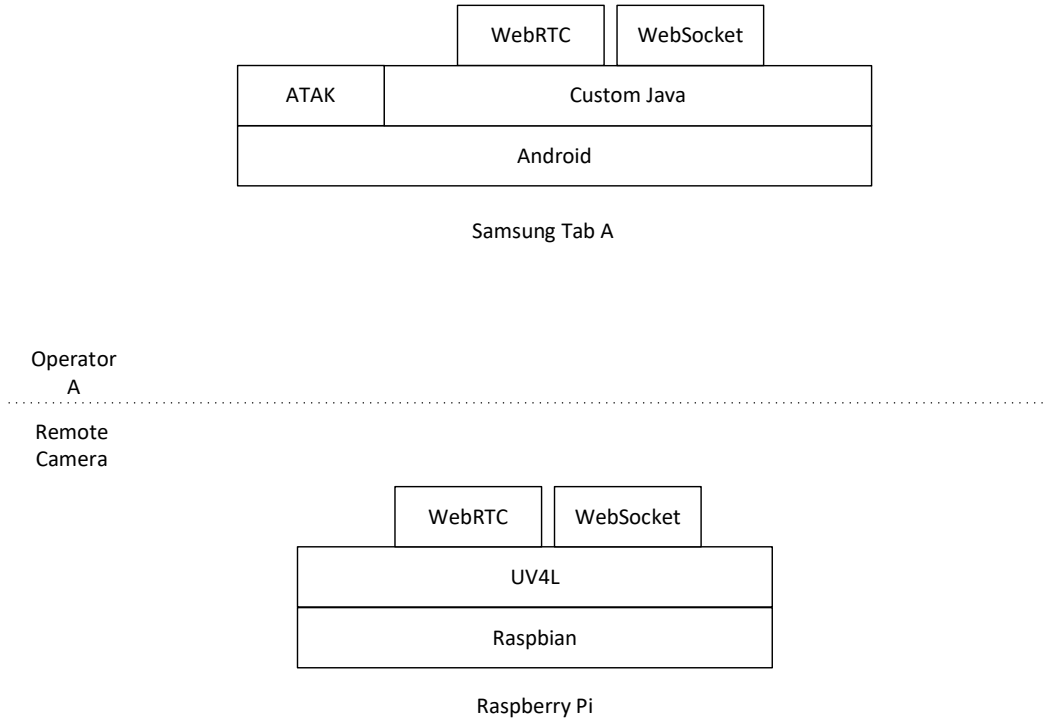

Figure 4 - ATAK to USB camera (U4VL) software architecture

The components of the software architecture on the ATAK device include:

- ***WebRTC*** – This is an open source framework that enables Real-Time Communications (RTC).
- ***WebSocket*** – This is a framework that provides messaging capabilities.
- ***ATAK*** – This is a government source framework that serves as an environment for the ALLCaP software.
- ***Custom Java*** – This is the custom Java application that allows the user to connect to and interact with a remote camera device.
- ***Android*** – An operating system for mobile devices.

The components of the software architecture of the camera subsystem include:

- ***WebRTC*** – This is an open source framework that enables Real-Time Communications (RTC).
- ***WebSocket*** – This is a framework that provides messaging capabilities.
- ***UV4L*** – This is a free package for streaming video and data.
- ***Raspbian*** – An operating system for the Raspberry Pi single board computers.

ATAK with multiple USB Cameras (webrtc-streamer)

This solution provides streaming video from one or multiple remote USB-based cameras. This architecture works over any IP connection like Wi-Fi or radio. The USB camera is connected to a Raspberry Pi (RPi) single board computer. The RPi is connected to an IP provider via Wi-Fi or an ethernet cable. The hardware architecture is the same as the one shown in Figure 3.

The software architecture is shown below:

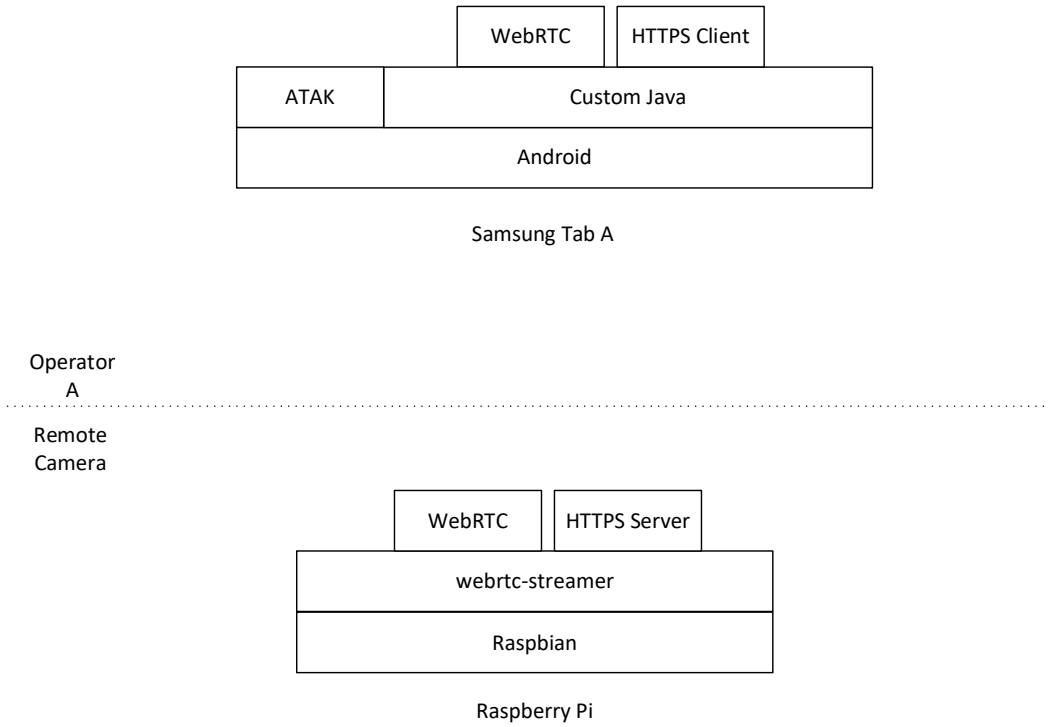

Figure 5 ATAK to multiple USB cameras (webrtc-streamer) software architecture

The components of the software architecture on the ATAK device include:

- ***WebRTC*** – This is an open source framework that enables Real-Time Communications (RTC).
- ***HTTPS Client*** – This software allows an application to act as a HTTPS client.
- ***ATAK*** – This is a government source framework that serves as an environment for the ALLCaP software.
- ***Custom Java*** – This is the custom Java application that allows the user to connect to and interact with a remote camera device.
- ***Android*** – An operating system for mobile devices.

The components of the software architecture of the camera subsystem include:

- ***WebRTC*** – This is an open source framework that enables Real-Time Communications (RTC).
- ***HTTPS Server*** – This software accepts and processes HTTPS requests.
- ***webrtc-streamer*** – This is an open source for streaming video.
- ***Raspbian*** – An operating system for the Raspberry Pi single board computers.

Demonstration

This section presents the user experience for both the *ATAK to ATAK* feature and *the ATAK to multiple camera* feature. The initial screen is the menu of plugins on the ATAK display.

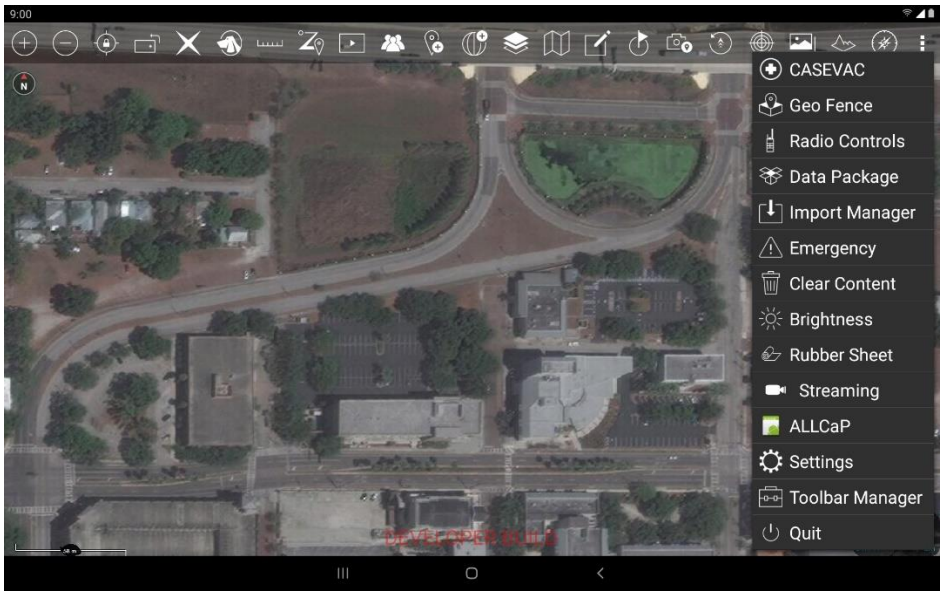

Figure 6 - Plugin menu screenshot

This version of the ALLCaP has two different items on the plugin menu, ***Streaming*** and ***ALLCaP***. Future versions of the software will consolidate the two into a single menu item. To select *the ATAK to ATAK* feature or the *ATAK to USB camera (U4VL)* feature, the user selects the ***Streaming*** item.

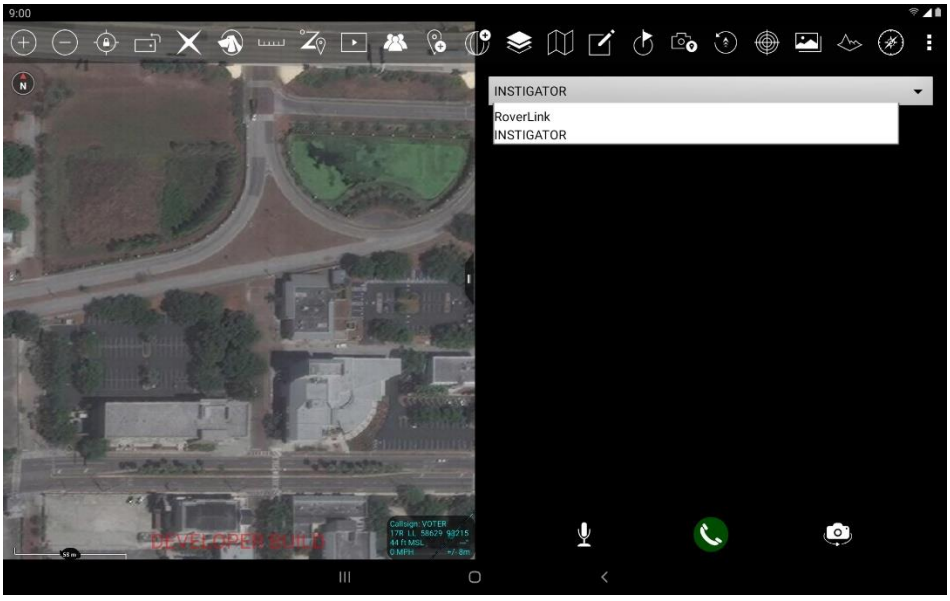

Figure 7- Screenshot of the camera options

The software is configured with two different camera options. The ***RoverLink*** item in the menu is a USB camera connected to a Raspberry Pi that is running the U4VL configuration. The ***INSTIGATOR*** item is the built-in camera on a remote ATAK device. If the user selects the ***INSTIGATOR*** item, the display will change to show the streaming video of the remote device as shown below:

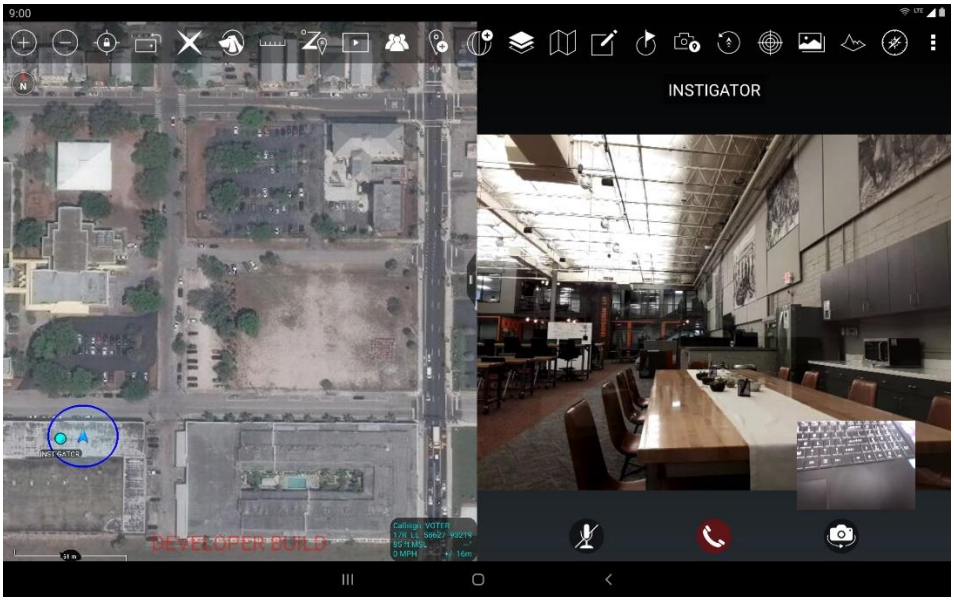

Figure 8 - Screenshot of remote ATAK built-in camera

If the user returns to the plugin menu, the following items are shown. The ***ALLCaP*** item will navigate to the multiple camera software.

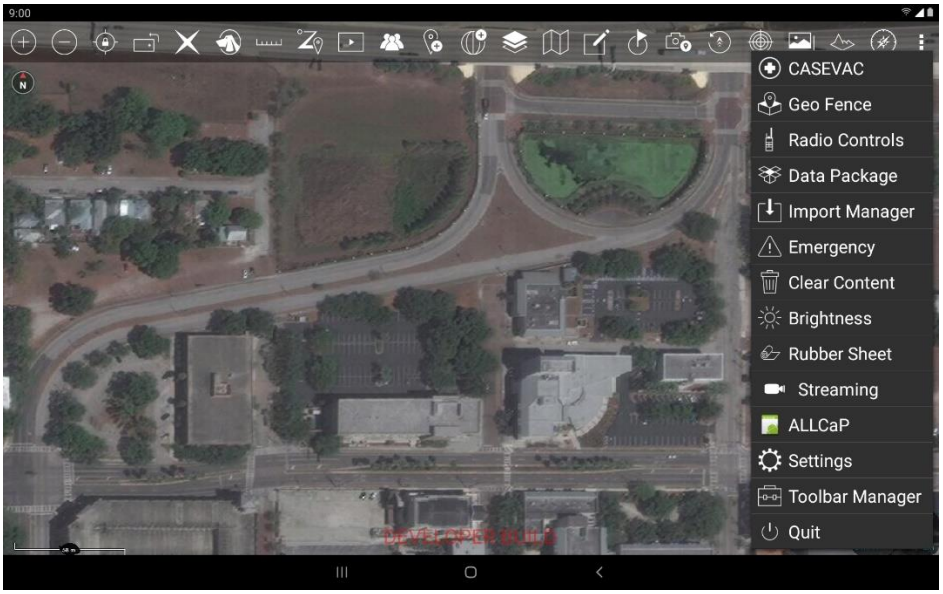

Figure 9 - Screenshot of plugin menu

The user may select one or more cameras that are configured. In the following screenshot, the available USB-based cameras are shown in a drop down menu.

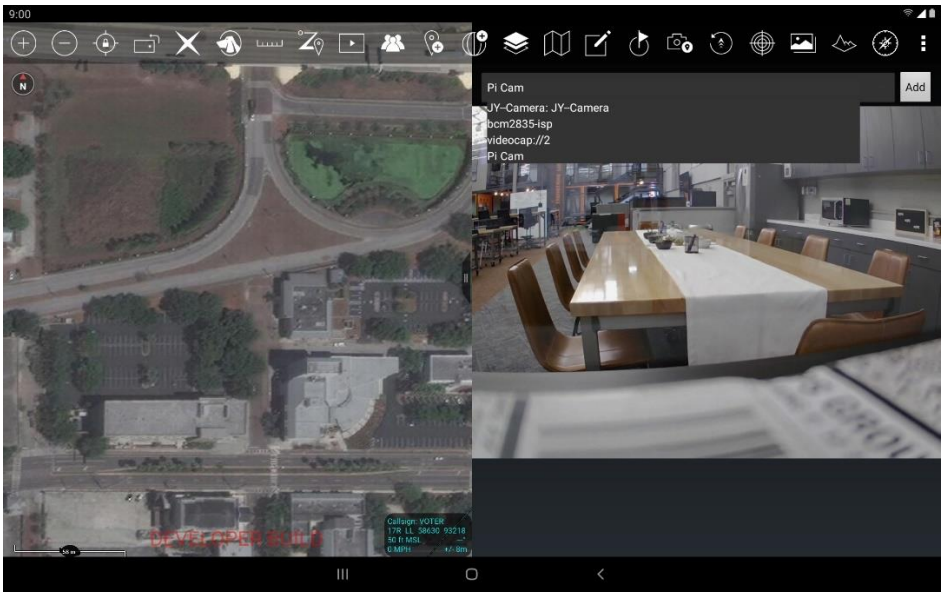

Figure 10 - List of camera options

Once a camera is selected, the display will add the streaming video from that camera.

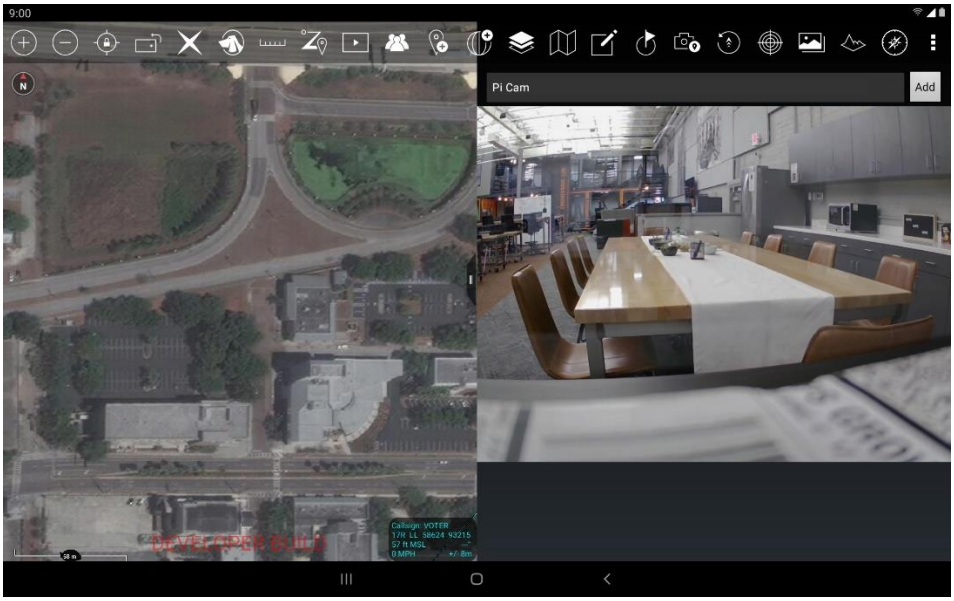

Figure 11 - Screenshot of streaming video

Where to Find

The repository with the source code is TBD.

Looking Back and Moving Forward

The ALLCaP solution to date was able to meet the key project objectives. The each of the three configurations measured ~200-230ms delay on Wi-Fi and ~400-420ms delay with the Trellisware radios.

The ATAK to ATAK alternative recorded the lowest cost requiring no additional hardware. To integrate the USB-based cameras, an inexpensive Raspberry Pi single board computer was used. All of the software packages and libraries were either open source or freeware.

The next steps in this effort focuses on the webrtc-streamer solution and continues to evolve the multiple USB camera functionality.