Tactical MANET Project Requirements

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February 6, 2021

1 Abstract

This document lists details of our graduation project requirements and specifications.

2 Project Description

A `mobile ad-hoc network` communication system for military, for operations in areas with no internet infrastructure. The system connects the command center(s) with deployed units in two-way communications.

3 System Architecture

The system is composed of devices (nodes) running linux-based operating systems and have certain programs running in them.

3.1 Nodes

All nodes are provided with wireless communication modules that follow `IEEE 802.11` standards.

There are 2 types of nodes: units and command centers.

3.1.1 Units

Devices with deployed units in the operation field, connected with:

- LCD screen with resolution of `48x84` pixels.
- Helmet video camera.
- Audio input.
- Keybad.
- GPS (or any other position detection system.)
- Heartbeat sensor.

Features:

- Low power consumption.
- Running on battery.
- Low wireless range.
- High mobility.
- Operated by one person.

3.1.2 Command Centers

High-end computers at the command and control centers, accessed by units leaders.

Features:

- Capabale of high power consumption.
- Powerfull CPUs.
- Big storage and RAM.
- Operated by multiple peeople with multiple wide screens.
- Wide wireless range.
- Installed nearby the operation field, and has a connection to devices in the field.
- Low (or zero) mobility.

3.2 Programs

Programs running in devices are running as daemons, started at the startup of the system and are always running and restarted on failure.

3.2.1 Units

Each unit has a public and private key, and a map of command centers `IP`s and their corresponding public keys.

> Extension: units announce their IPs to command centers and share their keys dynamically.

A unit device has 2 programs: - `Router`: implements routing protocol. - `Unit Client Daemon`: Connected to device hardware and network interface and provide all unit features.

3.2.2 Command Centers

Each command center has a public and private key, and a map of units IPs and their corresponding public keys.

> Extension: command centers announce their IPs to units and share their keys dynamically.

A command center computer has 3 programs: - `Router`: implements routing protocol, same router as in unit devices. - `Command Client Daemon`: Exposes an interface to `UI` program, connects to units clients and handles all communication with units. - `Command Client UI`: Connects to `Command Client Daemon`, shows all data in the daemon and controls it.

4 Functional Requirements

4.1 Units

- Stream video from combat-cameras to command center(s) only if the latter requested them. Video streaming terminates if the unit received end stream request, or the start request wasn't refreshed after 1 minute.
- Stream the heartbeat of the device owner and their position every 10 seconds.
- Store all the recorded video and sensors data locally, in a rolling db, where new data override old data when there is no left space. This feature could be controlled in a configuration file.
- If the owner requested:
  - Send audio messages from microphone.
  - Send code messages (every code has its predefined meaning.)
- Receive audio messages from command centers into a queue.
- Play received audio messages from the queue instantly.
- Receive and show code messages.
- Temporarily store audio and code messages.
- Access stored audio and code messages and delete them.

4.2 Command Centers

- Can be accessed from multiple computers.
- Send audio commands and command codes (every code has its predefined meaning) to one (unicast), some (multicast) or all (boradcast) of the deployed units devices.
- Store all received messages, video streams and other data (position and heartbeat).
- Show old archieved data.
- Play any audio message and video stream. Received messages don't autoplay, but the UI shows if a received message was already heard or not.
- Group units.
- Show map of all units, their group color.
- If didn't receive heartbeat and position from some unit for 2 minutes, mark it as inactive, show list of inactive units and show their latest position on map with inactive color.
- Show no-heartbeat warning, when some unit gives near-zero heartbeat for some time period. Color units with no heartbeat and show them clearly on map.
- Show statistics about selected unit or group of units. Statistics include:
  - their movement speed over time,
  - average/max/min/median speed,
  - and connection outages with command center over time.

5 Non-functional Requirements

5.1 Reliability

The following must be delivered reliably (with gurantee of delivery):

- Code messages.
- Audio messages.

The following can be delivered unreliably (*no* gurantee of delivery):

- Video streams.
- Position and heartbeat messages (minimum 80% delivery success rate).

5.2 Speed

The system allows nodes to communicate with low latency and high throughput. Video streams must be viewable at minimum of 20 fps.

5.3 Routing

TODO: define routing algorithm

The system uses a complex routing protocol that utilizes redundancy in the topology to increase communication reliability.

5.4 Security

- All transmitted data are encrypted.
- Authentiction is required for accessing command center by its UI.
- All stored data in command centers and units are encrypted.
- Units don't persist any data, messages self destruct after a 3 minutes of receiving them.

6 Testbeds

The system will be tested in 2 different environments: virtual and actual hardware.

6.1 Virtual

Using virtualization/emulation, each node (unit/command center) will be deployed in a virtual machine. Each node will have a static ip equivalent to that stored in nodes databases.

Ther should be `UI` for units' clients that: - connects with them over forwarded ports, - receives their screens and audio, - and sends them button actions and fake audio/video/position/heartbeat inputs,

Mininet-wifi will be used to simulate the wiereless connections and create topologies.

The following mobility models should be tested:

- Random Walk
- Truncated Levy Walk
- Random Direction
- Random Way Point
- Gauss Markov
- Reference Point
- Time Variant Community

Different toplogies with up-to 25 nodes should be tested.

6.2 Hardware

1. Install clients on our laptops.
2. Create a minimum topology with at least one command center.
3. Use the virtual `UI` for unit client.
4. Test streaming video/audio in a small ad-hoc network.
5. Remove one unit and test that the rest of the units noticed that and changed their routes.

   Extension: create actual hardware for the unit, modify the client to read actual inputs instead of taking them virtually.

7 Deliverables

- Source code of all programs listed in Subsection 3.2.
- Instructions on how to:
  - Configure devices, connect inputs.

  - Install all dependencies.
  - Configure all software.
  - Install and run all software.
- A paper that describes the modification(s) to the routing protocol, if any.
- Experiments' results about latency and throughput using different mobility models.