TRAIL BLAZERS

PORTABLE CYBERDECK

Understanding its origins and impact

PROBLEM STATEMENT

FOCUS AREAS

- Traditional surveillance (CCTV) lacks proactive detection.
- Secured zones (military, data centers, labs) are vulnerable to unauthorized physical intrusions.
- Devices carried by intruders emit RF signals that can be used to detect presence.

- RF SPECTROGRAM ANOMALY DETECTION USING MOBILENET-SSD ON PREPROCESSED SIGNAL DATA.
- DEPTH SENSOR-BASED MOTION TRACKING TO DETECT ACTUAL PHYSICAL MOVEMENT.
- SENSOR FUSION LOGIC TO CONFIRM INTRUSIONS BASED ON BOTH ELECTROMAGNETIC AND SPATIAL ANOMALIES.

WHAT WE ARE BUILDING

A hybrid intrusion detection system that detects the presence of unauthorized personnel in restricted areas

SYSTEM ARCHITECTURE

1. RF SIGNAL ACQUISITION LAYER

- Captures raw I/Q data from surrounding RF spectrum using Software Defined Radio (SDR) (e.g., HackRF, RTL-SDR).
- Frequencies monitored include:
- Wi-Fi (2.4 GHz & 5 GHz)
- Bluetooth
- GPS signals
- Cellular bands (optional extension

SYSTEM ARCHITECTURE

🧠2. RF ANOMALY DETECTION MODULE (MOBILENET SSD)

- Spectrograms passed through a pretrained + fine-tuned MobileNet SSD model.
- Trained to detect and classify signal types:
- Normal signals (authorized personnel/devices)
- Anomalies (e.g., unknown sources, spoofing, jamming)
- Fast inference time allows real-time classification of spectrograms

SYSTEM ARCHITECTURE

3. DEPTH SENSING MODULE

- Monitors the physical space using a depth-sensing camera (e.g., Intel RealSense D435).
- Uses OpenCV + Depth APIs for:
- Background subtraction
- Motion tracking
- Human-like silhouette detection
- Flag raised if unauthorized motion is detected.

SYSTEM ARCHITECTURE

4. SENSOR FUSION & DECISION LOGIC

- Both modules feed into a central Decision Engine.
- Only when both RF anomaly and depth motion are detected together within a time window, an intrusion alert is generated.
- Fusion logic ensures low false positives, maximizing precision.

```
+-------------+        +----------------+        +------------------+
| SDR Device  | -----> | RF Preprocessor| -----> | MobileNet SSD    |
+-------------+        +----------------+        +------------------+
                                                          |
                                                          v
                                                  [ Signal Type ]
                                                          |
                                                          v
+----------------+        +--------------------+        +--------------------+
| Depth Camera   | -----> | Motion Detector    | -----> | Decision Engine    |
+----------------+        +--------------------+        +--------------------+
                                                                   |
                                                                   v
                                                            [ Alert / Log ]
```

COMSTECH · OCT. 15, 2020

TECH STACK USED

🧠 ML/AI Models Used

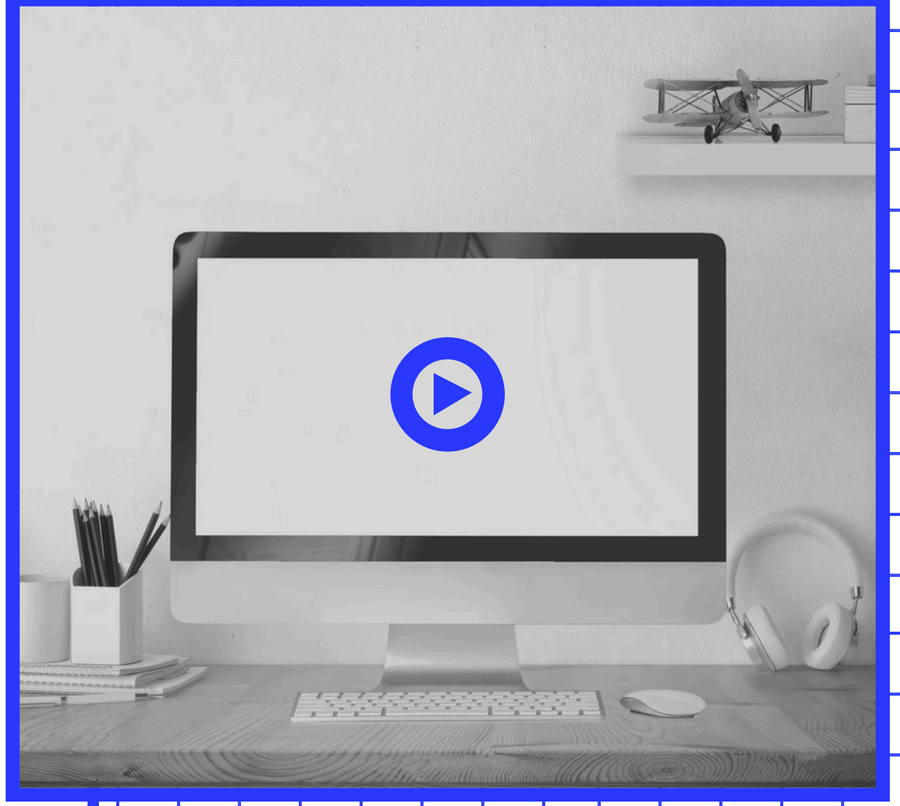
- MobileNet SSD
  - Lightweight real-time object detector
  - Fine-tuned for spectrogram classification
- (Optional) Depth-based movement classifier (if needed)

🛠️ Hardware Used

- RF Frontend: RTL-SDR dongle / HackRF One
- Depth Sensor: Intel RealSense D435 / Azure Kinect
- Controller Board: Raspberry Pi 4 / Jetson Nano (optional edge deployment)

☁️ Deployment

- Local on-device processing (Raspberry Pi or Jetson)
- Optional cloud dashboard for alerting & visualization



OUTPUT and OUTCOMES

SIGNAL-BASED INTRUSION DETECTION

- 📈 RF SPIKE DETECTION:
- SYSTEM ANALYZES REAL-TIME RF WAVEFORMS TO DETECT SUDDEN SIGNAL SPIKES OR UNEXPECTED FREQUENCY PATTERNS, WHICH MAY INDICATE UNAUTHORIZED WIRELESS DEVICES.
- 📊 ANOMALY CLASSIFICATION:
- SPECTROGRAMS ARE CLASSIFIED TO DISTINGUISH BETWEEN NORMAL ACTIVITY AND POTENTIAL INTRUDER SIGNALS (E.G., JAMMERS, ROGUE DEVICES).

OUTPUT and OUTCOMES

VISUAL DETECTION WITH DEPTH SENSOR

- HUMAN DETECTION:
- USES MOBILENET SSD FOR DETECTING PEOPLE IN THE CAMERA'S FIELD OF VIEW, EVEN IN LOW-LIGHT OR LOW-VISIBILITY ENVIRONMENTS.
- POSTURE RECOGNITION (OPTIONAL ADD-ON):
- ABILITY TO UNDERSTAND WHETHER A PERSON IS STANDING, CROUCHING, OR LYING DOWN - USEFUL FOR IDENTIFYING SUSPICIOUS BEHAVIOR.

OUTPUT and OUTCOMES

SENSOR FUSION OUTCOMES

- HIGH ACCURACY INTRUSION DETECTION
- COMBINES RF ANOMALY DETECTION WITH DEPTH-BASED VISUAL CUES TO ELIMINATE FALSE POSITIVES.
- REAL-TIME ALERTS
- SENDS ALERT TO SECURITY DASHBOARD WHEN INTRUSION IS CONFIRMED BY BOTH RF + VISION SYSTEMS.

Cost Efficiency & Practical Advantages

Why Our Solution is Better Than Traditional Surveillance

Smart + Low-Cost Hardware

- Uses MobileNet SSD, a lightweight model → Runs on edge devices
- No need for expensive GPUs or large power setups

Leverages RF Signals

- Avoids full dependency on high-res cameras
- Low bandwidth requirement for RF monitoring

Multi-Modal Detection = Less Hardware

- Combines RF spike detection + depth sensing + basic vision
- Reduces need for multiple dedicated systems

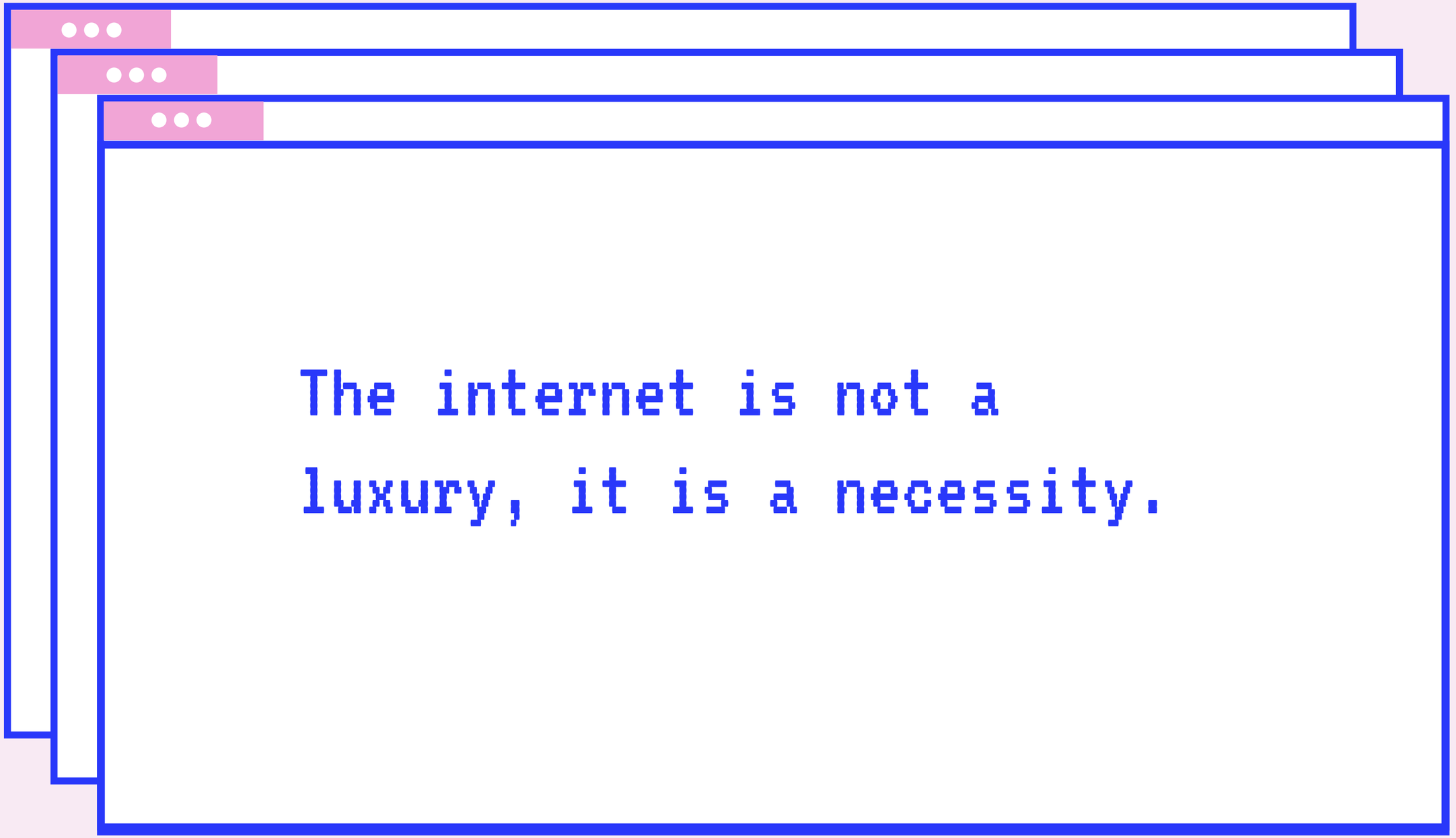
Easy to Deploy & Maintain

- Plug-and-play sensors, no complex cabling
- Can run on Jetson Nano, Raspberry Pi, or similar cheap edge devices

Estimated Cost:

- 70% cheaper than traditional AI surveillance setups
- Lower training and inference costs due to lightweight architecture

FUTURE SCOPE


The internet is not a
luxury, it is a necessity.

thank you

TEAM TRAIL BLAZERS