Smart Locks Re-engineered : Securing IoT devices using Steganography

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Introduction

- 21st century = Century for Internet of Things
- Phenomenal growth in interconnected devices -> Threats
- Result = Insecurity of Things
- Objective - Robust security solution to existing IoT devices like Smart Locks
- Reason -
  - Providing extra layer of security
  - Improve the existing architecture of IoT devices

Motivation

- Most IoT devices use Bluetooth Low Energy protocol.
- Number of vulnerabilities associated with the Bluetooth Low Energy (BLE).
- Primary vulnerability in BLE = Man in the Middle (MITM) attack
- Steganography overcomes MITM attack

Literature Review

Overview and Evaluation of Bluetooth Low Energy: An Emerging Low-Power Wireless Technology, Carles Gomez , Joaquim Oller and Josep Paradells, Sensors, ISSN 1424-8220, 2012	● BLE Protocol Stack explained ● Potential threats of BLE ● 3 phases in Bluetooth pairing. ● Vulerability of Just Works.
Secure Internet Banking Authentication Hiltgen, A., Kramp, T., Weigold, T. IEEE Security and Privacy 2006	● Prevention of MITM attack by using Short-term password solutions (OTP) E.g. VeriSign, Active Card

Literature Review

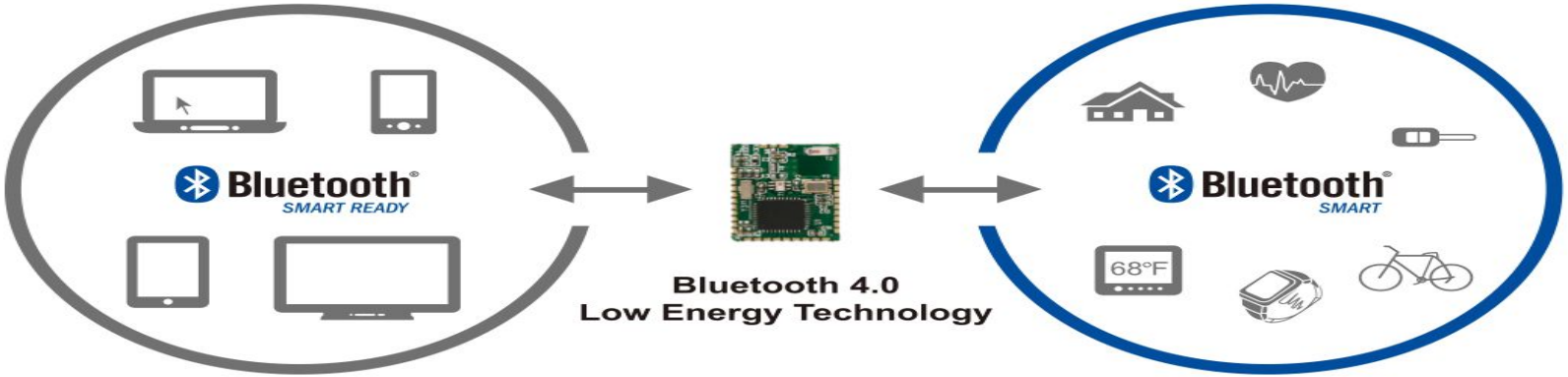
SMS-Based One time Password vulnerabilities and safeguarding OTP over network A. Karia, A. B. Patankar, and P. Tawde 2014	● Counter MITM and phishing attack on authentication and authorization ● Vulnerability - Wireless interception, Mobile phone trojans, SIM Swap attack
Stepping Up Internet Banking Security Using Dynamic Pattern Based Image Steganography P. Thiyagarajan, G. Aghila, and V. Prasanna Venkatesan Springer-Verlag Berlin Heidelberg 2011	● Utilizing Steganography for protection against MITM attack. ● Man-in-the-Middle attack principle ● Proposed - Stego-layer method ● Prevents MITM and Session Hijacking

Current Smart Lock System

- Smart Locks uses BLE protocol
- BLE protocol vulnerable to MITM attacks
- Just Works - Phase 2 of BLE Pairing - Vulnerability
- Less Secure

Bluetooth Low Energy Protocol

- Wireless technology based on low power consumption
- Allows short range communication
- IoT devices (smart locks, proximity sensors, heart rate monitors) work on BLE
- BLE has greater deployment expectations than other low power technologies such as Zigbee, 6 LoWPAN, Z-Wave

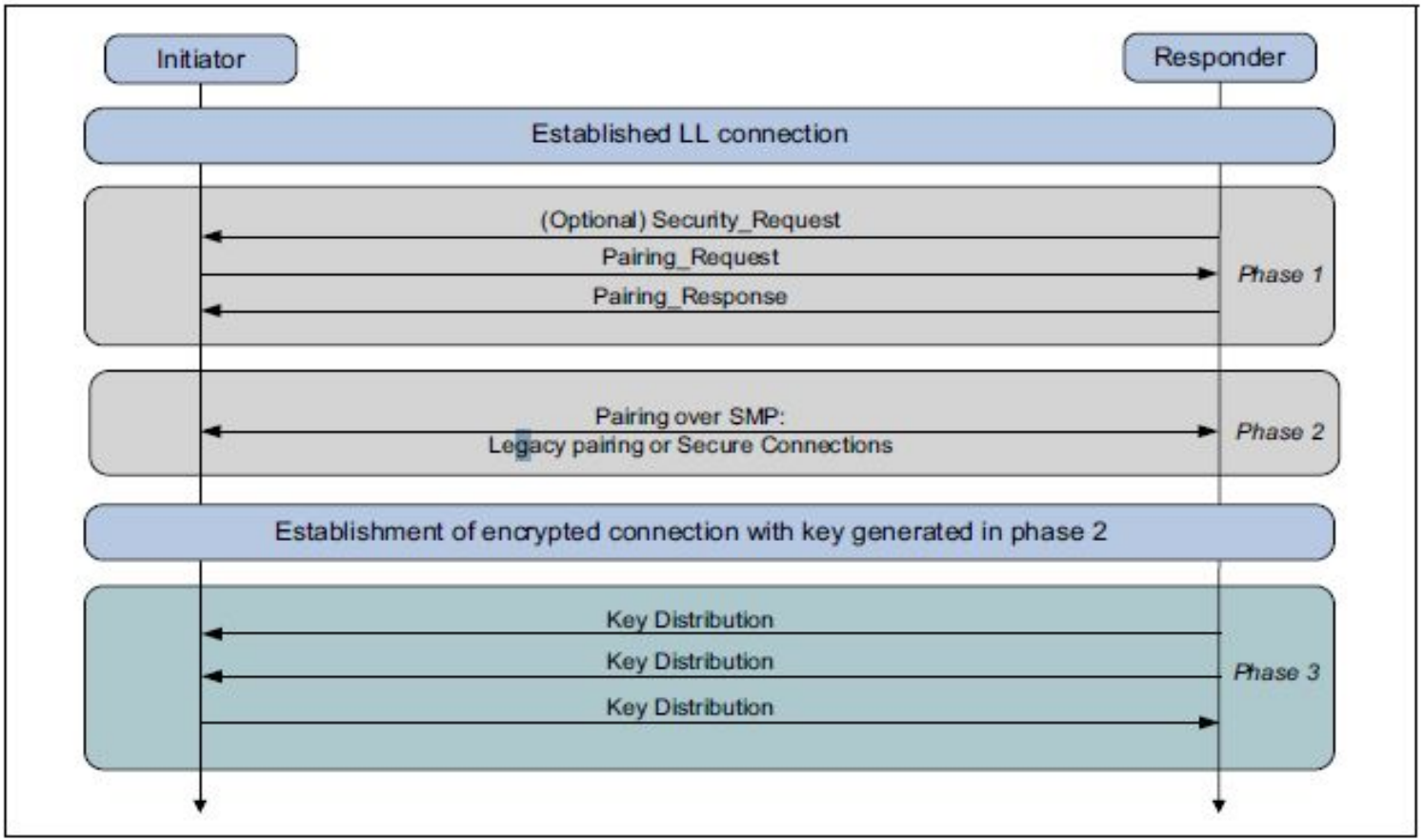


Security at the Link Layer

- 128-bit AES block cipher
- Cipher Block Chaining-Message Authentication Code (CCM) Protocol
- Secure pairing done in 3 phases:

1. **Phase 1**: Devices announce their I/O capabilities
2. **Phase 2**: Generation of STK (Short Term Key) and agreement on TK (Temporary Key)
3. **Phase 3: LTK (**Long Term Key**), CSRK** (Connection Signature Resolving Key)**, IRK** (Identity Resolving Key) are shared between end-points

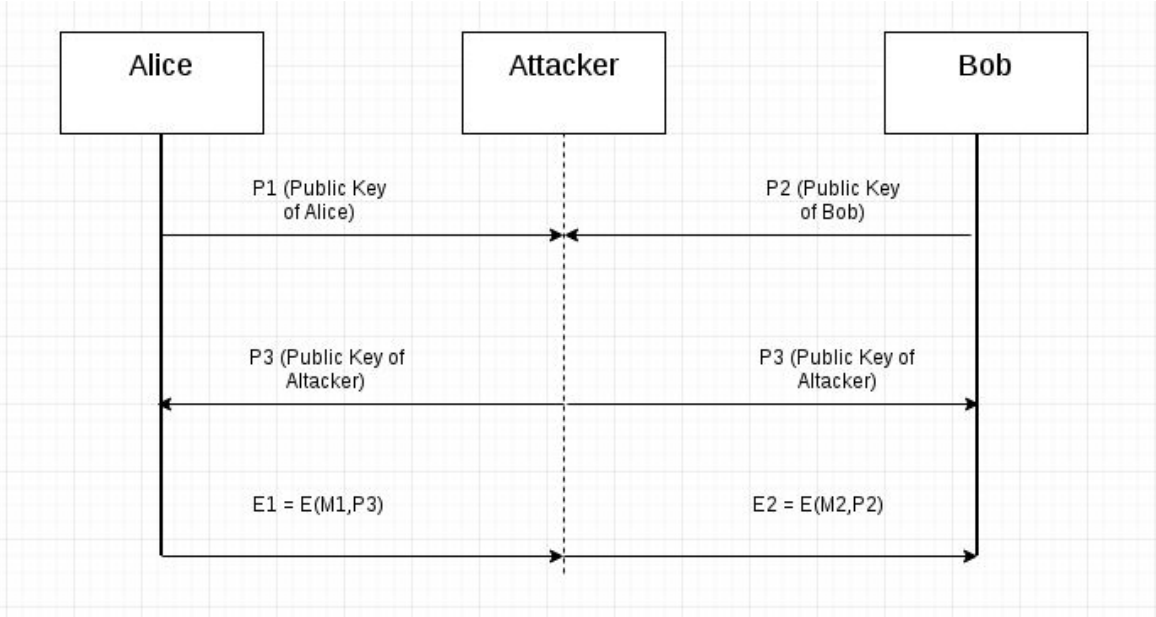
Pairing in BLE protocol using SMP



Vulnerabilities in BLE

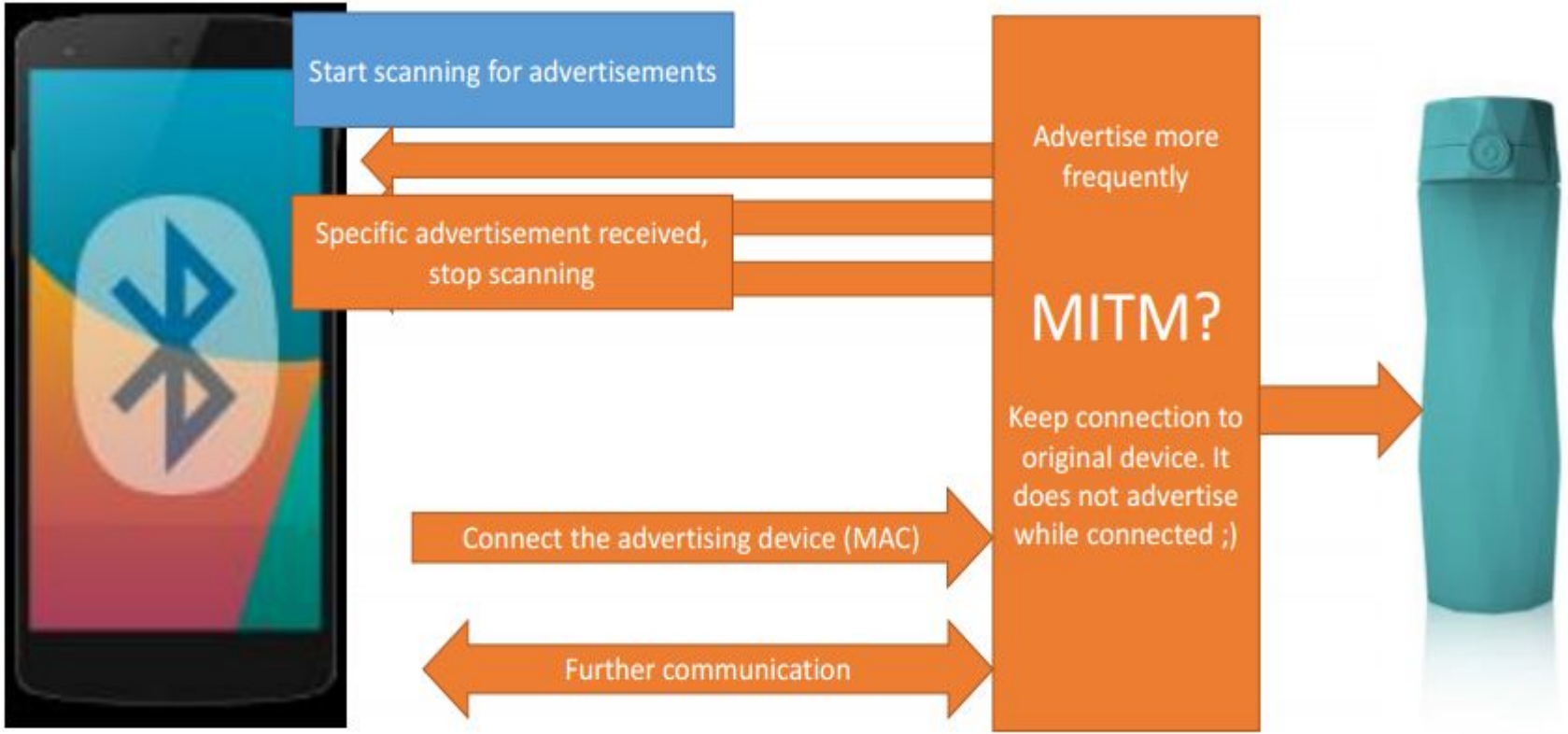
- In the 2nd Phase of pairing, 3 methods can be used- JustWorks, PassKey Entry, Out of Band Communication (NFC)
- Using JustWorks makes BLE susceptible to Man-in-the-Middle attack
- Eavesdropping
- Denial-of-Service

Man-in-the-Middle Attack



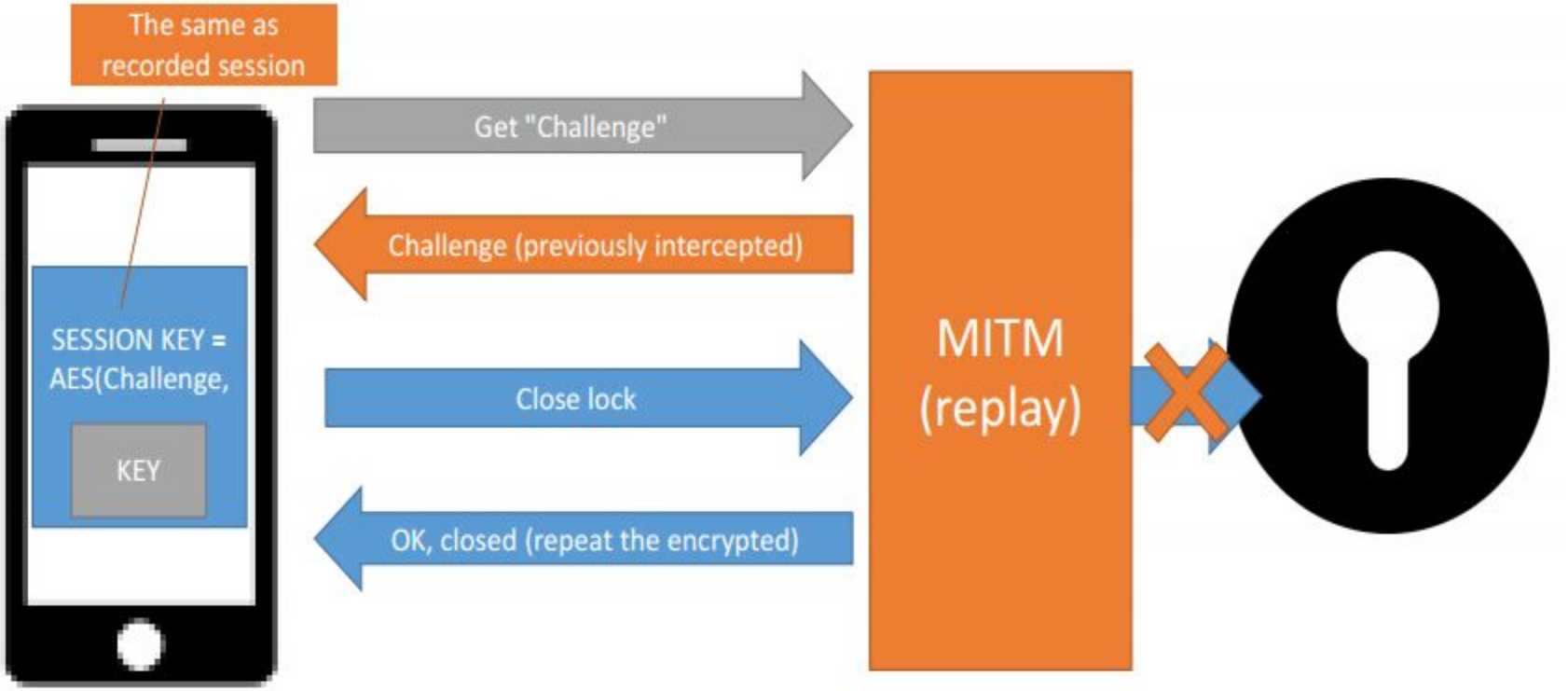
- Intruder secretly relays and possibly alters communication between 2 devices
- BLE devices susceptible to MITM in the pairing phase

MITM



Reference - GATTACKING BLUETOOTH SMART DEVICES Author - Slawomir Jasek, SecuRing Year - 2016

Smart lock – attack



Reference - GATTACKING BLUETOOTH SMART DEVICES Author - Slawomir Jasek, SecuRing Year - 2016

Steganography

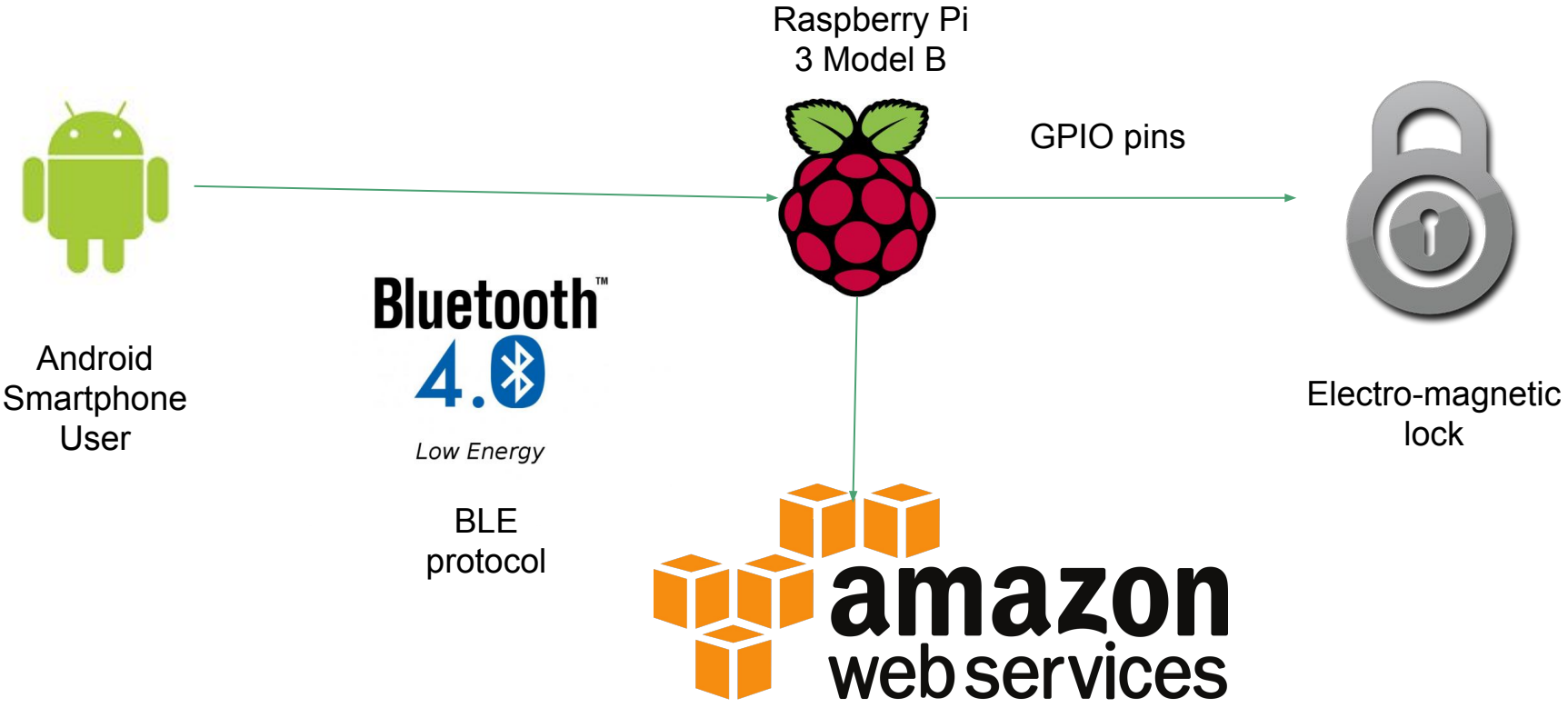
- Definition - “art of hiding a message”
- History - German spies in 1914-18
- Techniques -
  - Technical
    - Hiding in Stego-files (audio.video,image)
  - Text
    - Hiding in text
      - Format-based
      - Random & statistical

Observation

- Aim- Resolve the shortcomings of the existing Bluetooth Low Energy (BLE) protocol used in the IoT devices (Smart lock).
- Steganography - hiding the message in a larger message or image so as to hide the existence of the message itself
- Cryptography - the study of hiding information i.e. converting data into gibberish form and sending it.
- Our AIM,

Improved security = Cryptography + Steganography

System Design



Hardware & Software Requirements

- Hardware Requirements:
  - Smartphone
  - Raspberry Pi 3 Model B
  - Electro-magnetic Lock

- Software Requirements
  - Python 2.7 and Java SE 1.8 (programming on Raspberry Pi)
  - Android application

Circuit Diagram

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THANK YOU