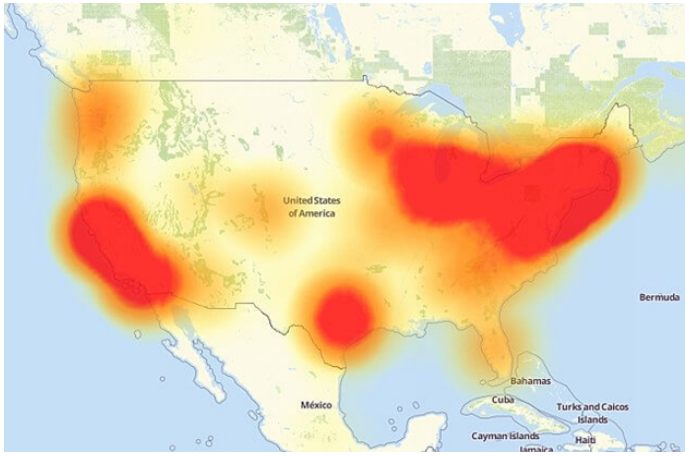
IoTrain-Sim Overview

IoT Training System Using the Cooja Network Simulator

Motivation

- The growth rate of Internet of Things (IoT) devices is exponential, predicted to reach 50 billion in 2020
- Design and implementation issues will cause serious problems regarding IoT safety/security
- People lack knowledge and awareness of IoT security, hence IoT security education and training are extremely urgent



Effects of Mirai DDoS attacks in the USA

Source: https://www.theverge.com/2016/10/21/13362354/dyn-dns-ddos-attack-cause-outage-status-explained

About IoTrain-Sim

- IoTrain-Sim is an integrated system for IoT security training and education
  - Provides training tutorials, simulation examples, and hands-on exercises to users
  - Content is divided into fundamental and security training
  - Contiki OS and the Cooja simulator are employed for the hands-on exercises
- Due to the characteristics of the tools used, the training scope is currently limited to Wireless Sensor Networks (WSN) and RPL-based IoT networks

Contiki OS

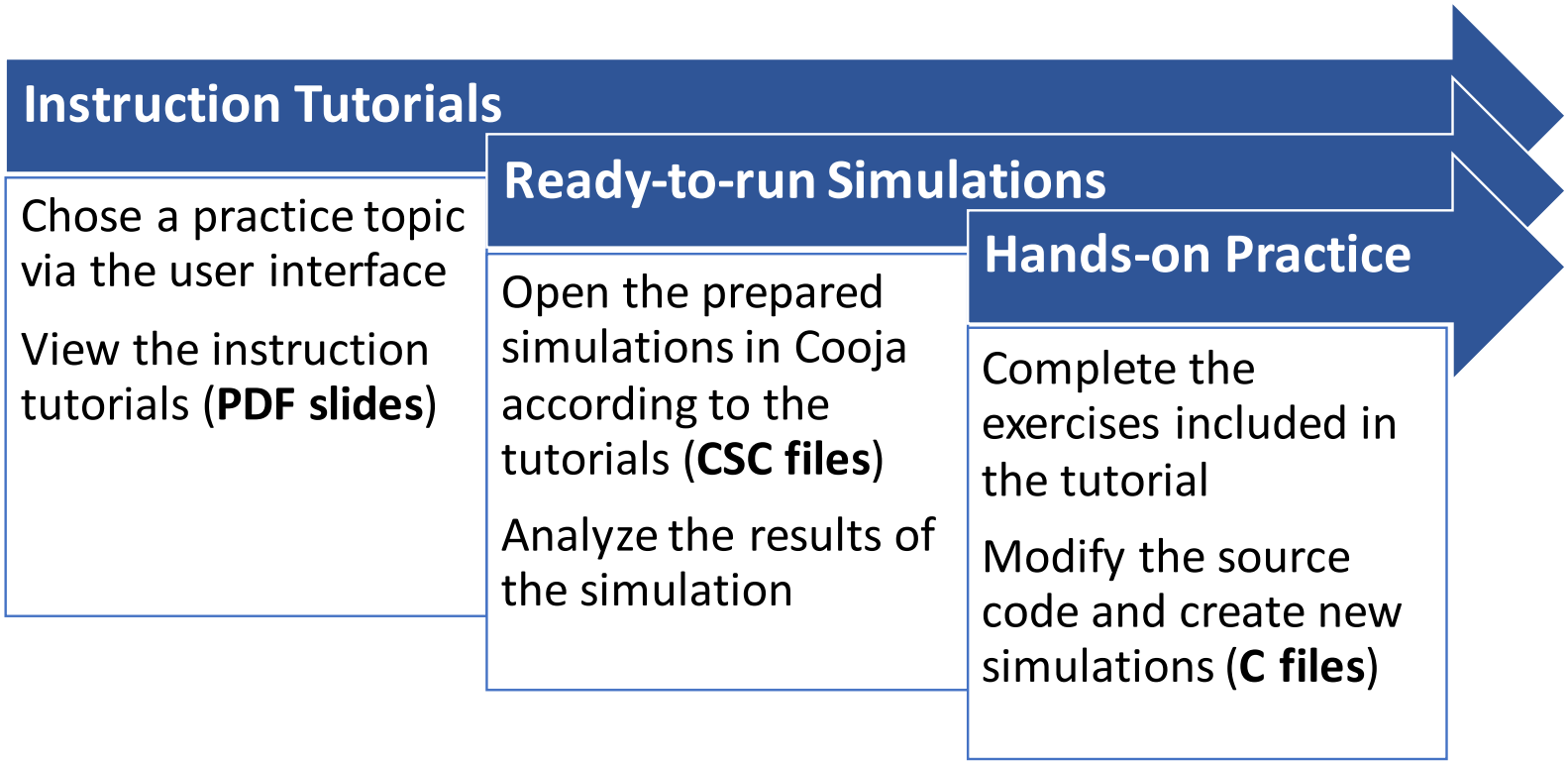
- Contiki is an open-source operating system for IoT devices
  - Helps connects tiny low-cost, low-power microcontrollers
  - Powerful toolbox for building complex wireless systems
  - Supports fully standard IPv6 and IPv4, along with recent low-power wireless standards, 6LoWPAN, RPL, CoAP
- Contiki applications are written in standard C, and using the Cooja simulator systems can be emulated before deployment
- As there are many examples in the Contiki source code to help users get started, and most have a Cooja simulation available, we considered Contiki & Cooja to be very suitable tools for IoTrain-Sim
  - For more information, see http://www.contiki-os.org/

Cooja Simulator

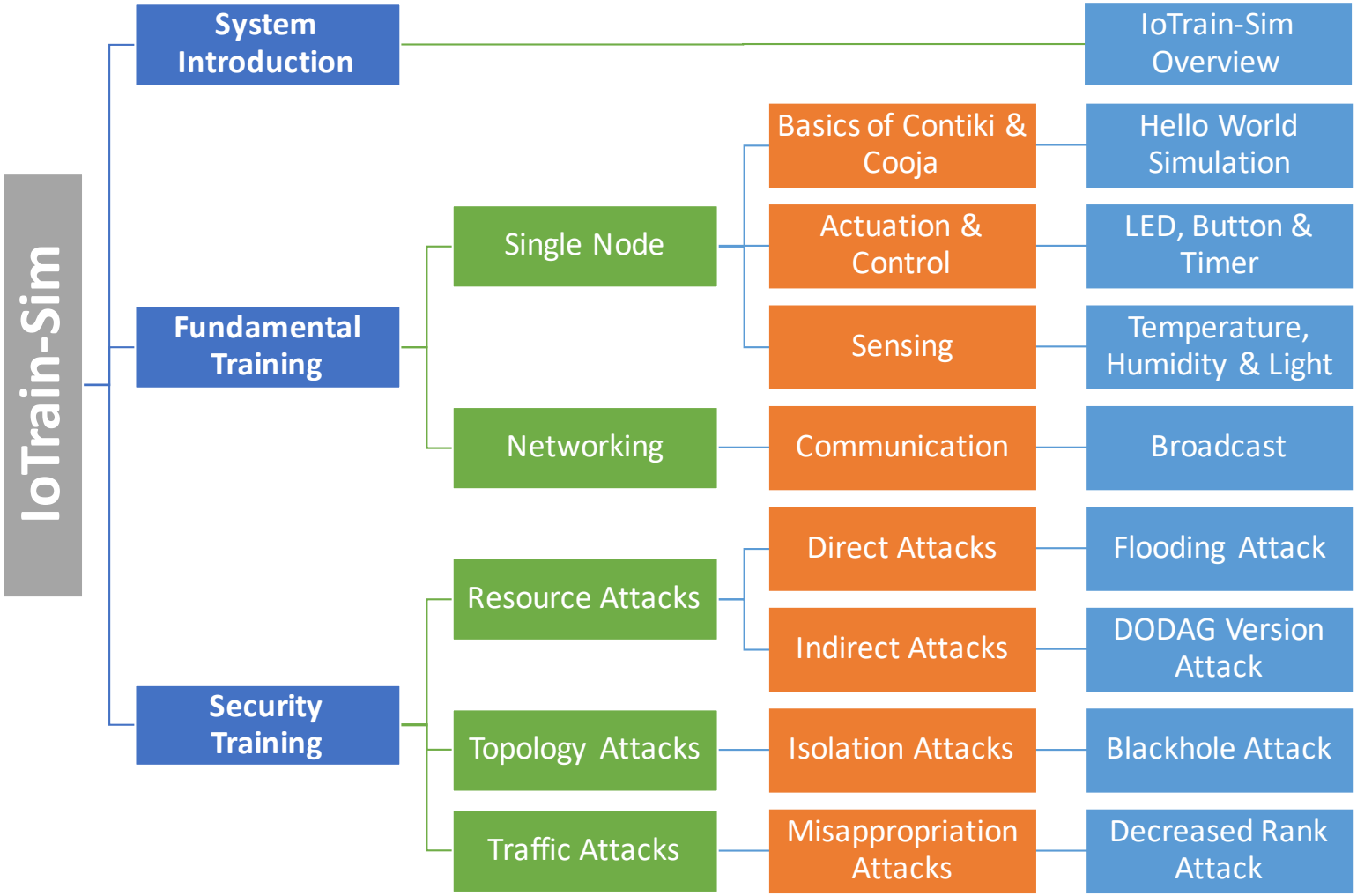
- Cooja is a Contiki OS network simulator
  - An extensible Java-based simulator capable of emulating Tmote Sky (Z1 or other) nodes
  - Compiles Contiki for the native platform as a shared library, and loads the library into Java using Java Native Interfaces (JNIs)
- The code to be executed by the simulated nodes is the exact same firmware you may upload to physical nodes
- Provides a simulation environment that allows developers to see their applications run in large-scale networks or in extreme detail on fully emulated hardware devices

Training Workflow

- Training using IoTrain-Sim is typically conducted as illustrated below



Content Overview



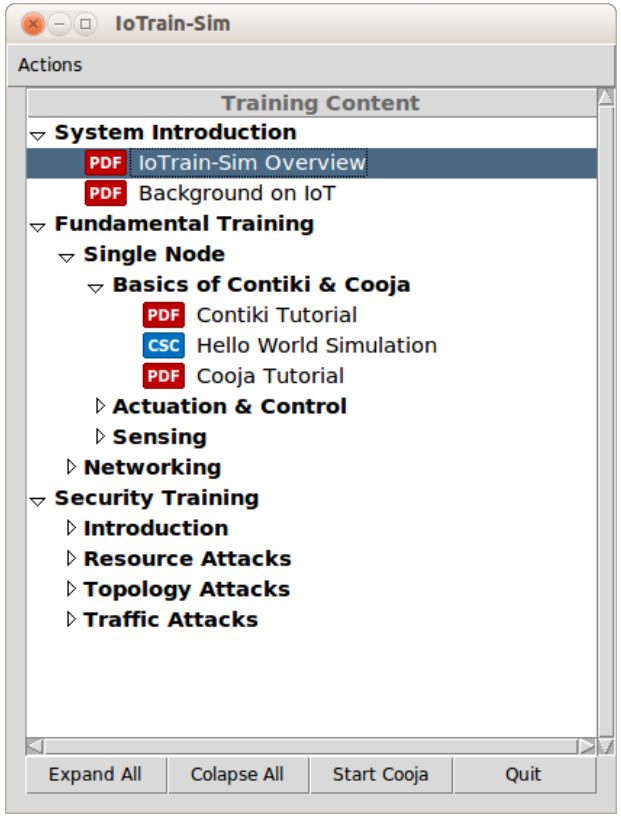
Fundamental Training

- **Single Node**
  - Basics of Contiki & Cooja
    - Hello World simulation
  - Actuation & Control
    - LED, button, timer programming in Contiki & Cooja
    - Hands-on exercises
  - Sensing
    - Temperature, humidity and light intensity sensor simulation
    - Sensor programming in Contiki & Cooja
- **Networking**
  - Communication
    - Broadcast tutorial

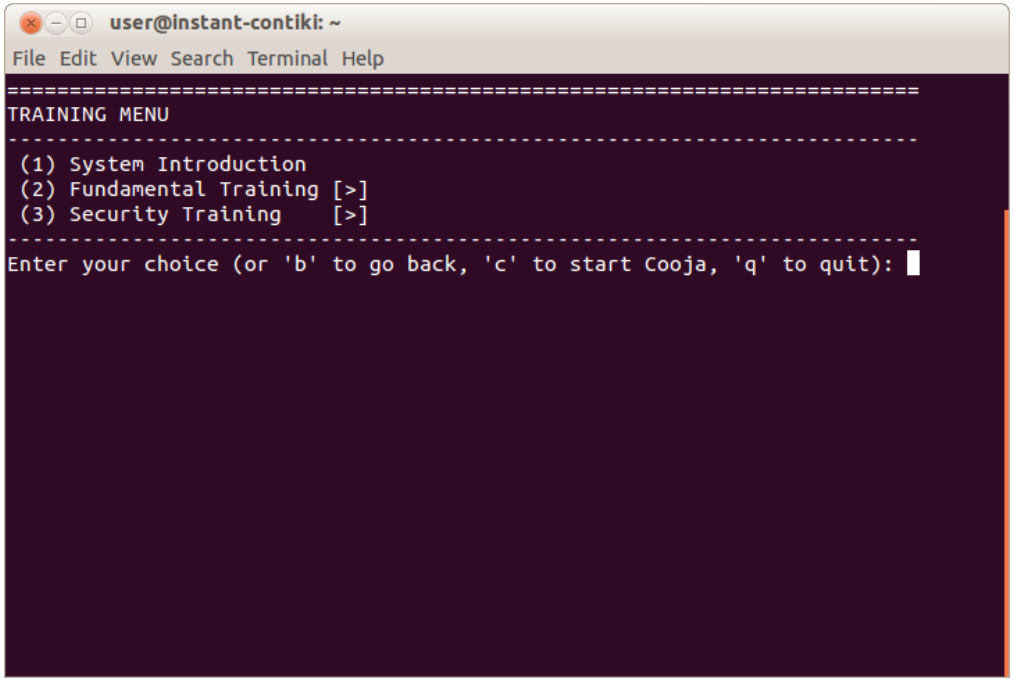
Security Training

- **Resource attacks**
  - Direct attacks
    - RPL DIS flooding attack
  - Indirect attacks
    - RPL DODAG version number attack
- **Topology attacks**
  - Isolation attacks
    - Blackhole attack
- **Traffic attacks**
  - Misappropriation attacks
    - Decreased rank attack

IoTrain-Sim User Inteface



Graphical User Interface



Command Line Interface (optional)

For further utilization details, see the file README.md included in the IoTrain-Sim release