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FISSURE: The RF Framework

GNU Radio Conference 2022

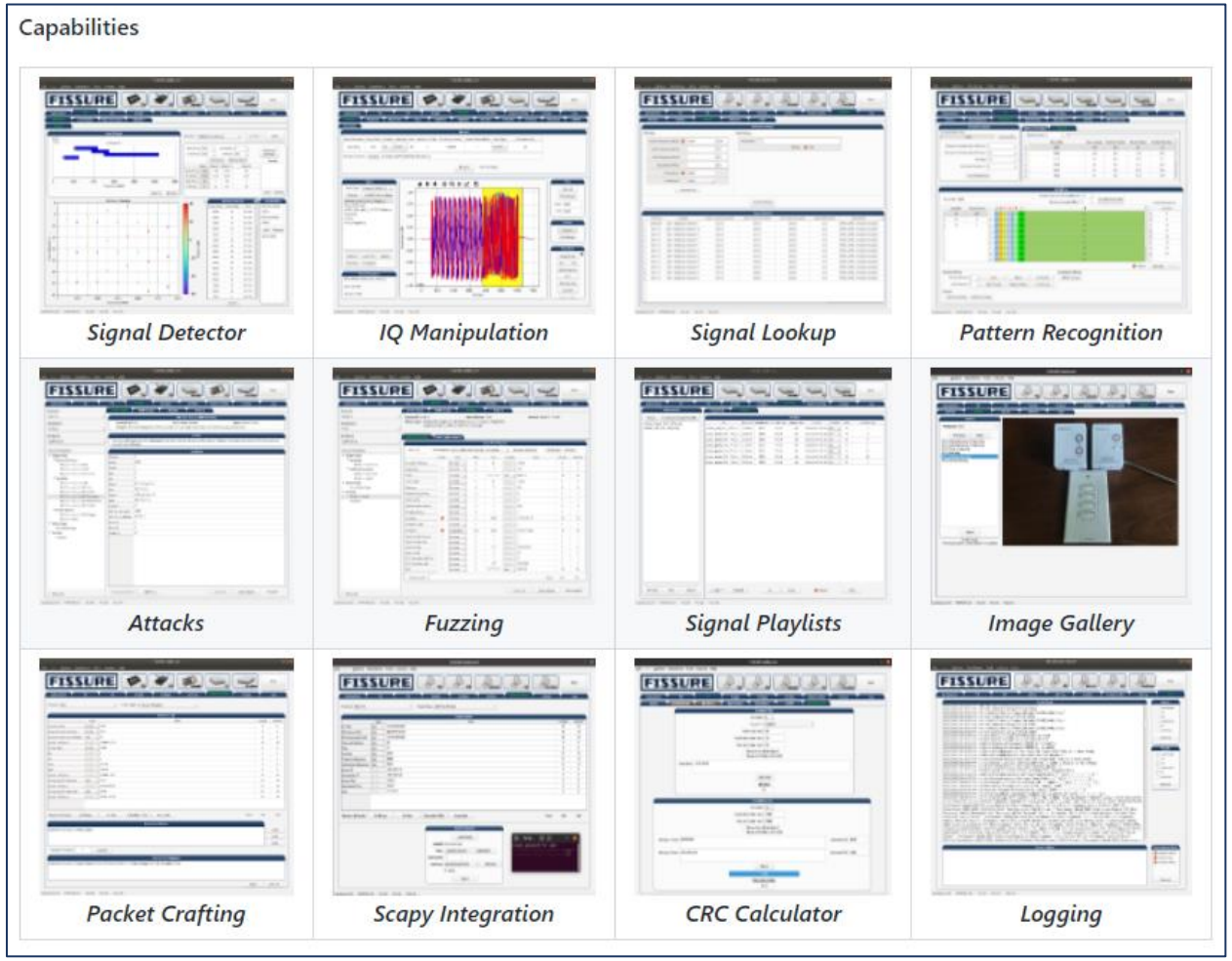
Outline

- Summary
- Origins
- Core Principles
- Component Details
- GNU Radio Integration
- Roadmap
- Contributing

FISSURE – The RF Framework

Summary

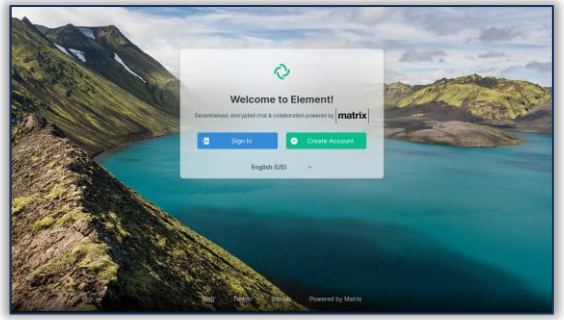
- Open-source RF and reverse engineering framework
- Contains hooks for detection, classification, protocol discovery, attack execution, vulnerability analysis, automation, AI/ML
- Consolidates all-things RF: software modules, radios, protocols, signal data, scripts, flow graphs, reference material, and third-party tools
- Speeds up the characterization of signals and the identification of vulnerabilities in RF protocols, waveforms, and devices
- Mostly Python & PyQt with support for legacy systems
- Out-of-the-box, pain-free software installer
- Meant for everyone: experts and beginners, edit pieces on your own

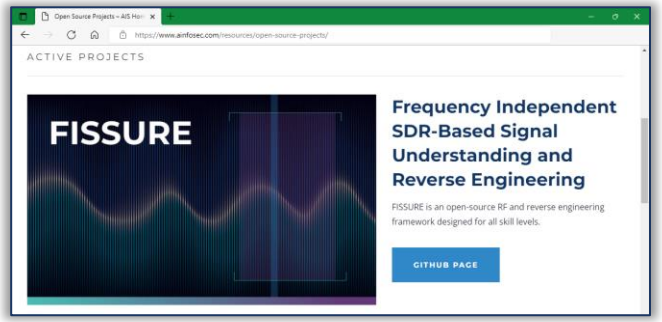


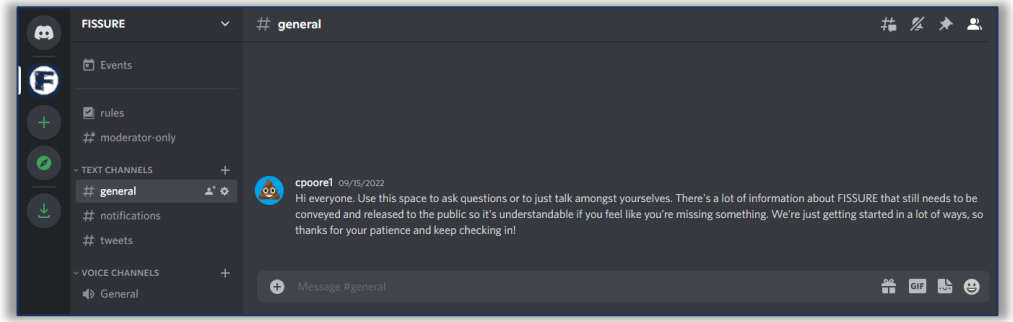
FISSURE – The RF Framework

Summary

- On GitHub since August 10, 2022
- Promoted at DEF CON Demo Labs August 12, 2022
- You may have seen:
  - Griffiss Institute Lecture + Education Series April 28, 2021
  - 2021 C4I and Cyber Technology Conference August 3, 2021
- Learn more at:
  - Twitter (@FissureRF)
  - Discord (see GitHub)
  - chat.gnuradio.org (cpoore1)
  - Reddit (r/FISSURE)
  - ainfosec.com (future)



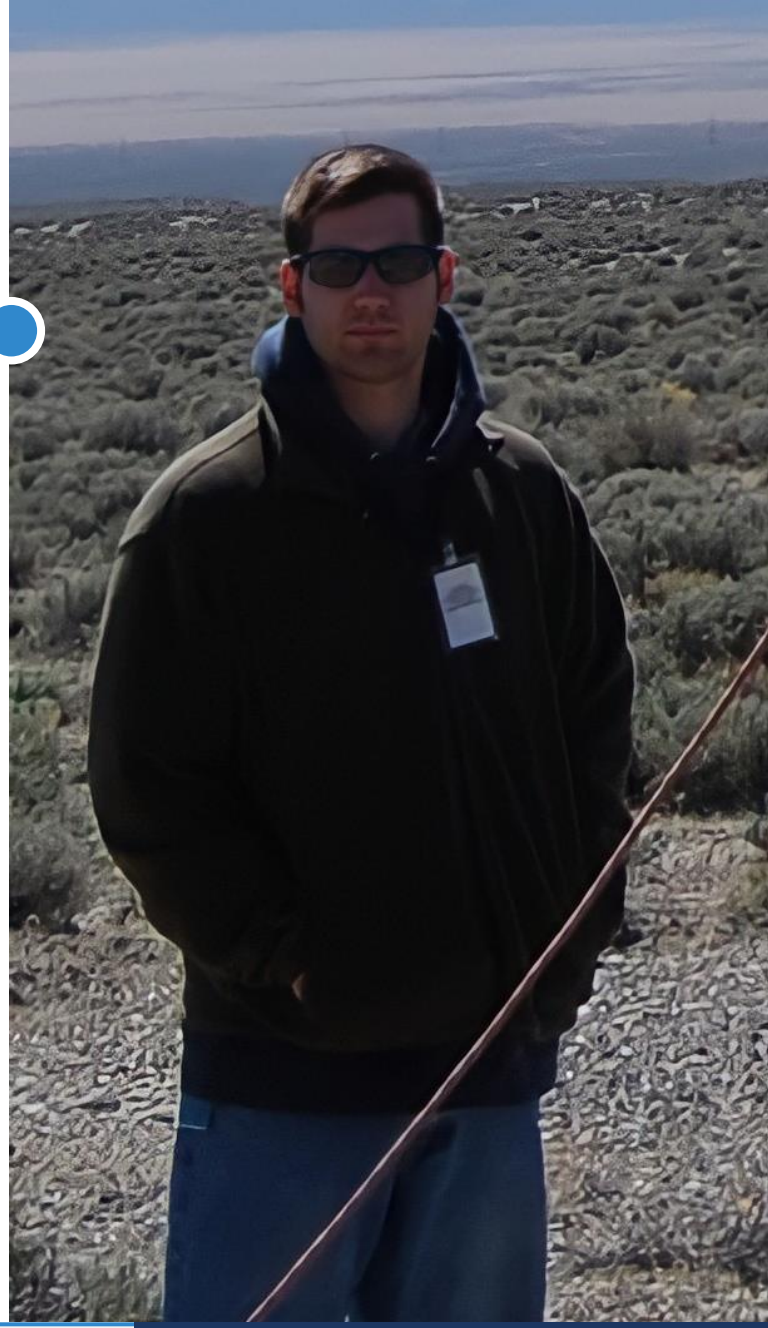




Origins

Background & Context

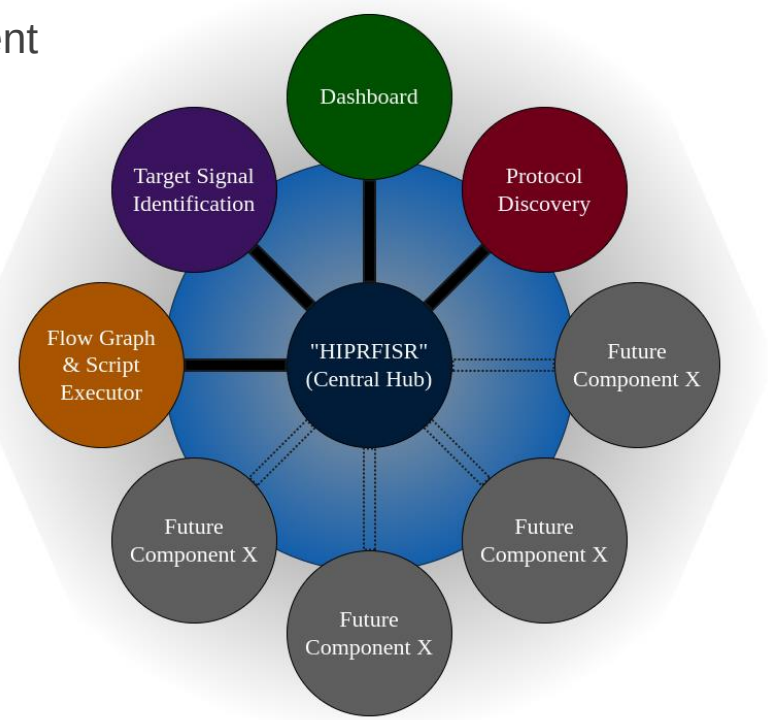
Mr. Chris Poore
AIS, *Senior Reverse Engineer*



- Electrical engineer at a cybersecurity company
  - Assured Information Security, Inc. (HQ: Rome, NY)
    - Advanced Research, Cyber Operations, Intelligence Analysis, Security Testing, Trusted Systems
    - Artificial Intelligence, Machine Learning, Computer Architectures, Behavioral Science, Software and Malware Analysis, Virtualization, Cross Domain Solutions, Reverse Engineering, Embedded Systems, Penetration Testing, and more
- Worked on RF projects entire career
  - Constantly jumping around to different technologies with each project
  - Always something/somewhere new
- I need to know everything about the different RF technologies to:
  - Characterize systems
  - Assess security
  - Exploit and interact with targets
  - Perform research
  - Develop tools
  - Teach others

Origins

- **What does FISSURE mean?**
  - **F**requency **I**ndependent **S**DR-based **S**ignal **U**nderstanding and **R**everse **E**ngineering
- **Where did it come from?**
  - 2014 project for designing a flexible system for automatic RF device assessment
  - Internal research and development over several years
- **What does it look like?**
  - PyQt GUI with many tabs and menu items
  - Dedicated Python components communicating to a central hub over ZMQ
  - YAML schema for input sanitization and error handling
- **Why extend it to the Open-Source community?**
  - Makes all our jobs easier
  - Brings in outside knowledge
  - Benefit future generations
  - Revolutionize engineering and cybersecurity



Principles

The Fundamental Elements of FISSURE

- Speed up signal characterization
- Support rapid integration of existing tools and algorithms
- Provide flexibility to support new features
- Consolidate useful software and information
- Access commonly performed operations
- Allow data to be passed over a network and between components
- Contain transparent, easy-to-understand code
- Help with identification of vulnerabilities in protocols and devices
- Utilize commercial SDRs and other commonplace hardware
- Be a testbed for AI/ML and automation
- Promote RF and Cyber in education
- Easy-to-use, helpful visualizations
- Simple and reliable installation
- Support the latest and legacy

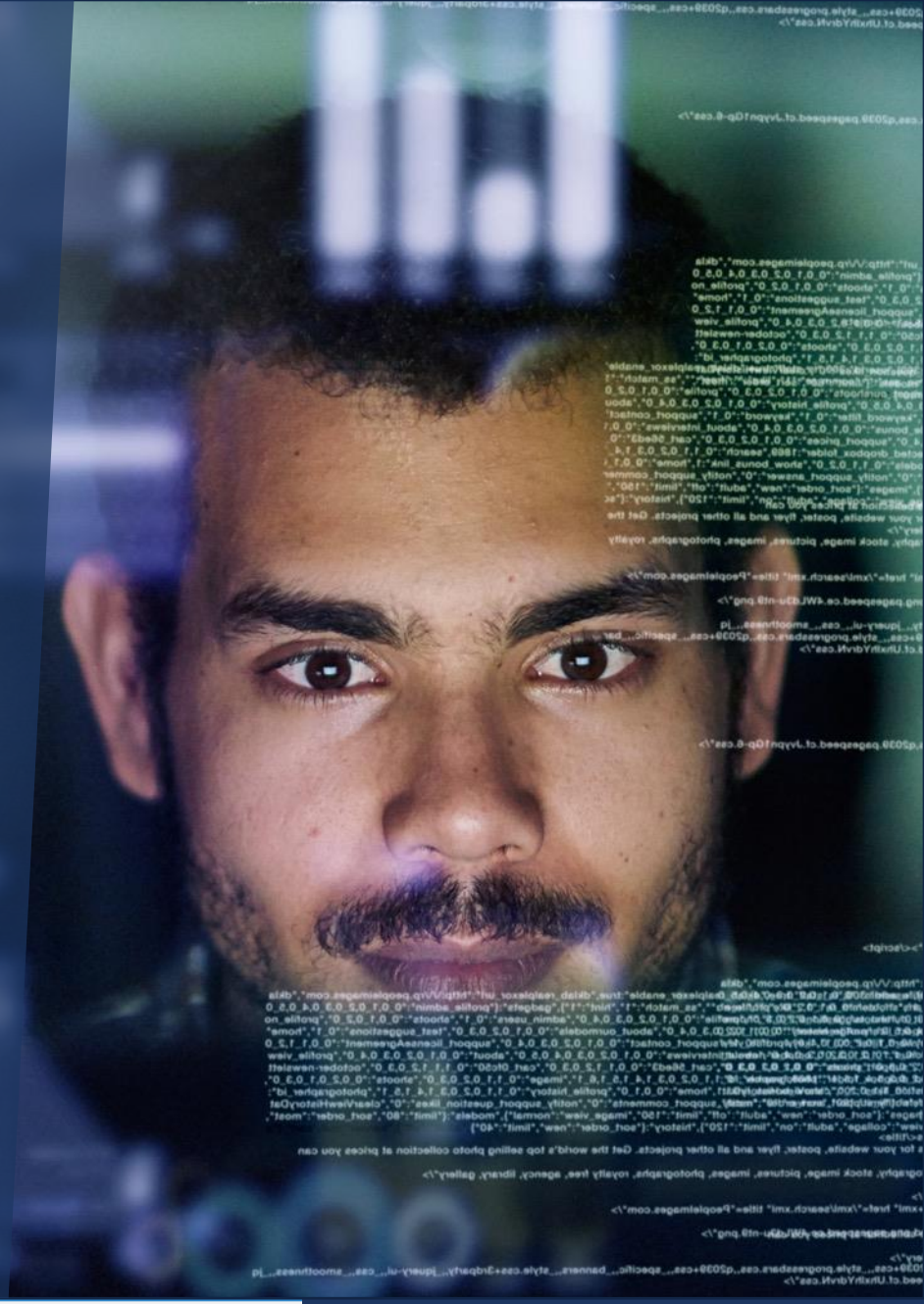
Principles

FISSURE is a Framework

- Not a finished product, it will look different over time
- Filled with examples of how to do things
- Everything can be improved, nothing is complete, and more can be integrated
- Requires feedback from the community
- Will adapt to help as many as possible
- Needs to be built up before automation can have a larger role
- Meant for everyone
  - Experts can expose cutting-edge solutions
  - Professionals can perform their daily tasks
  - Educators can teach
  - Students, hobbyists, developers can learn

Components

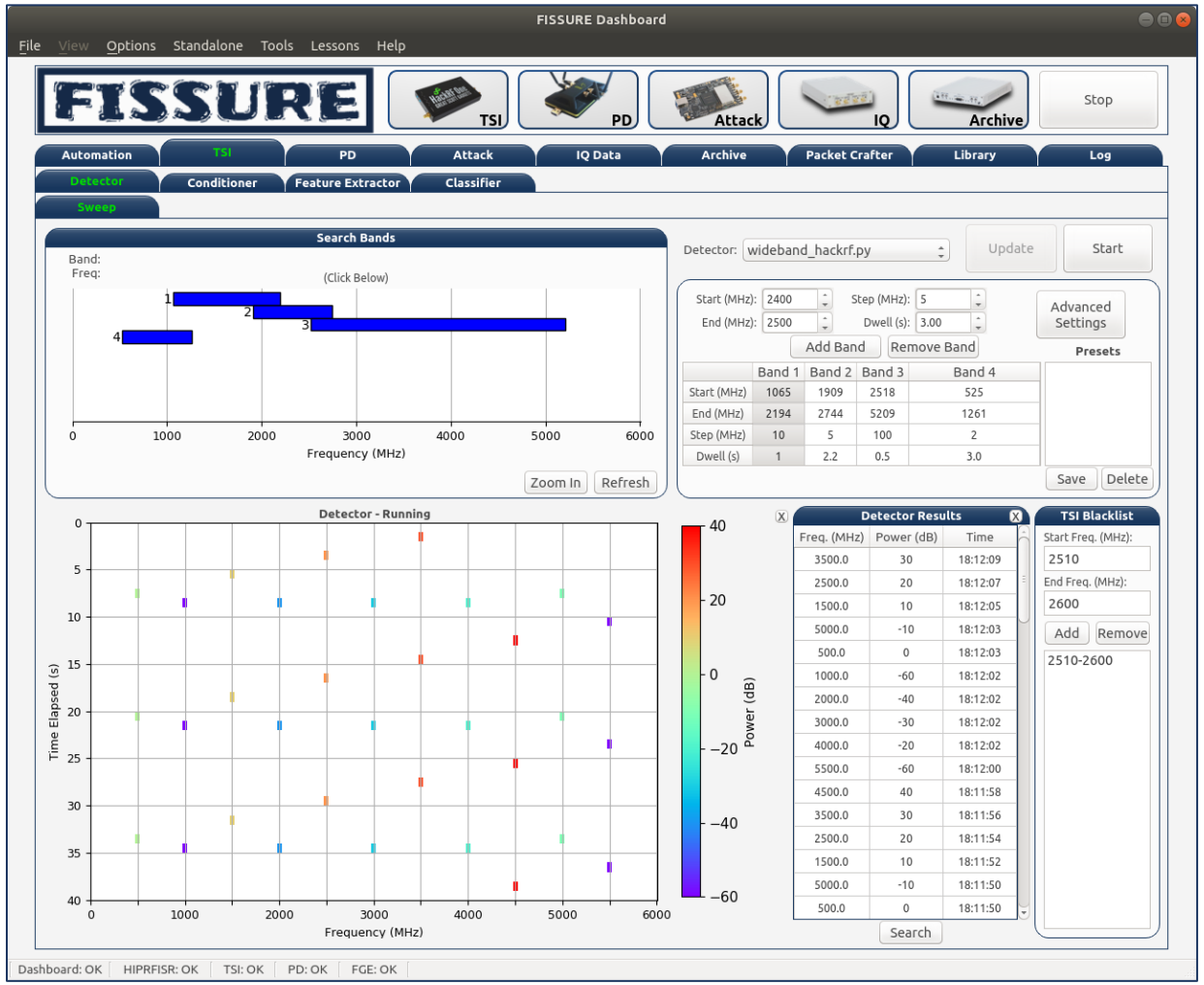
- Target Signal Identification
- Protocol Discovery
- Attacks
- IQ Manipulation
- Online Signal Archive
- Packet Crafting
- Third-Party Tools
- Lessons



Components

Target Signal Identification

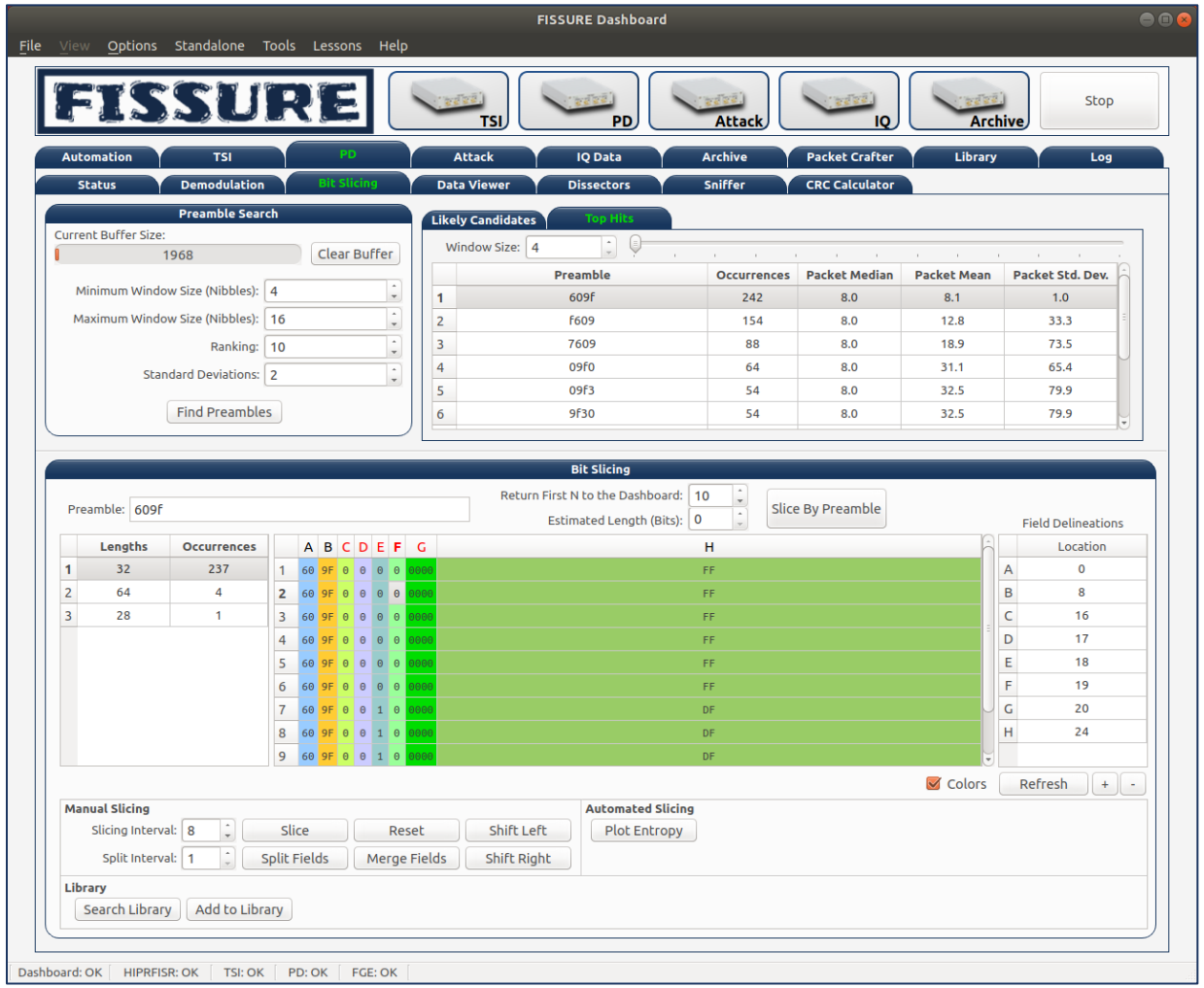
- Detector
  - Fast-scanning, slow-scanning
  - Power, frequency, time
- Signal Conditioner
  - Isolate, condition signals from a stream of raw I/Q
- Feature Extractor
  - Extract predetermined list of signal characteristics dependent on AI/ML classification method
- Protocol/Emitter Classifier
  - Interpret feature sets and provide confidence levels for protocol and emitter classification
- Future
  - hackrf_sweep, rtl_power fast-scanning detectors
  - Swap and compare AI/ML techniques, automation



Components

Protocol Discovery

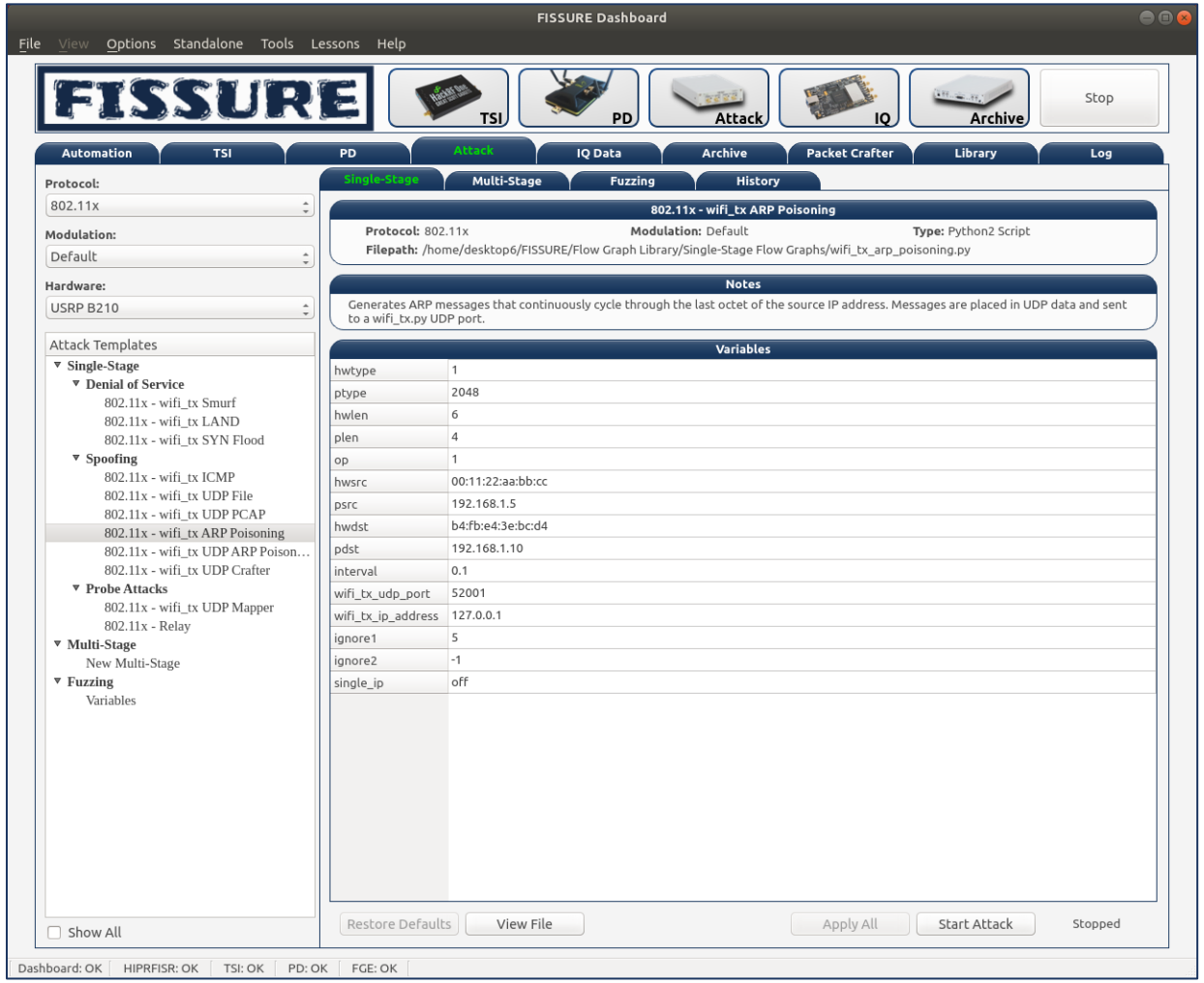
- Recursive Demodulation
  - Load flow graphs, extract signal parameters, work towards a bitstream
- Bit Slicing
  - Identify patterns in a circular buffer filled with data to isolate fields and add messages to the library
- Data Viewer
  - Manipulate bits, view hex, compare to known protocol & message formats
- Custom Dissectors
  - Create Lua Wireshark dissectors and view/record messages returned from demodulation flow graphs
- CRC Calculator
  - Apply common CRC algorithms
  - Find the CRC polynomial from two messages with known CRCs
- Future
  - Parameter acquisition, protocol confidence levels, pattern recognition, variable length messages



Components

Attacks

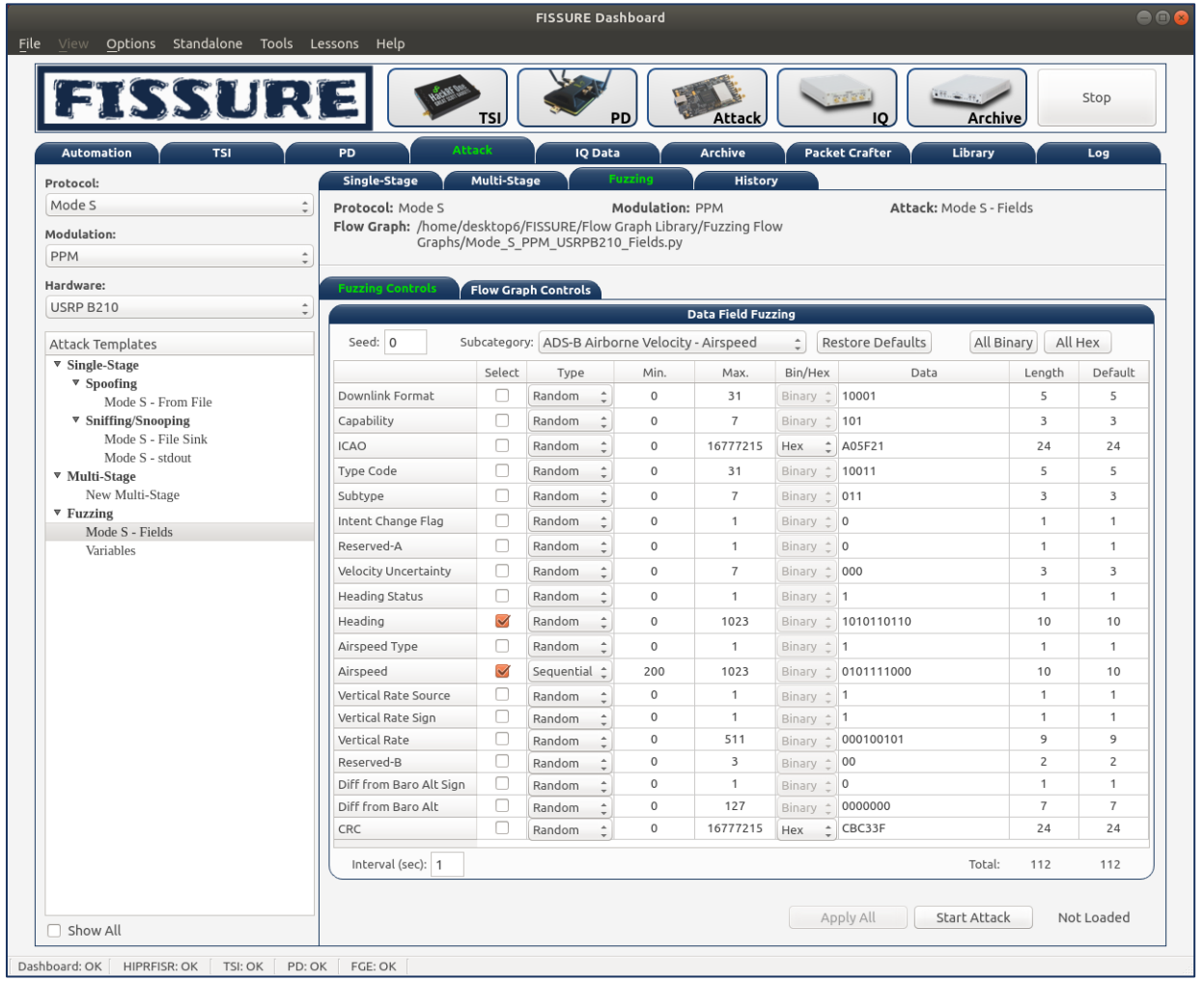
- Single-stage
  - Python2/Python3 scripts
    - Simple header added to the file for default values
  - Flow Graphs with/without GUIs
  - Wireless or wired applications
- Multi-stage
  - String multiple attacks in succession
  - Run each one on a loop for a specified duration



Components

Attacks (Continued)

- Data field fuzzing
  - Check Fields
  - Choose random or sequential fuzzing
  - Specify ranges for fuzzing
  - Enter a transmit interval
  - Automatically recalculates CRCs
- Flow graph variable fuzzing
  - Fuzz individual GNU Radio variables for blocks with callbacks
- Future
  - More attacks
  - Further hardware support
  - Vulnerability analysis



Components

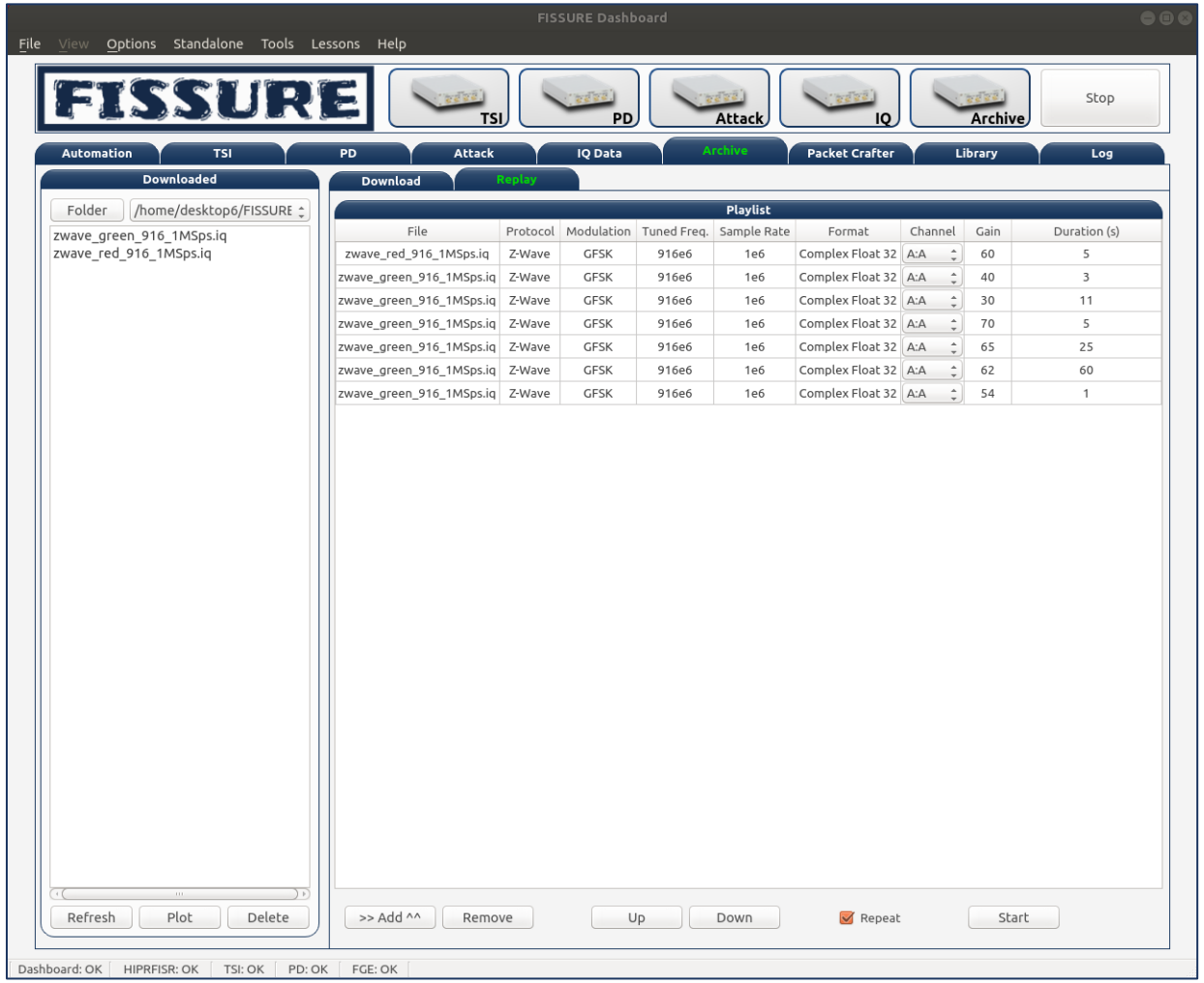
IQ Manipulation

- Live inspection flow graphs
- Record and playback
- View data
  - Plot, zoom, pan, save, measure
- Modify data
  - Crop, convert, append, apply timeslots, overlap, resample, OFDM analysis, normalize
- Perform analysis
  - Magnitude, instantaneous frequency, spectrogram, FFT, moving average, morse code, polar plot
- Future
  - Time/frequency measurement, obtaining symbol rates
  - Radar data analysis
  - Filtering
  - Better inspection flow graphs

Components

Online Signal Archive

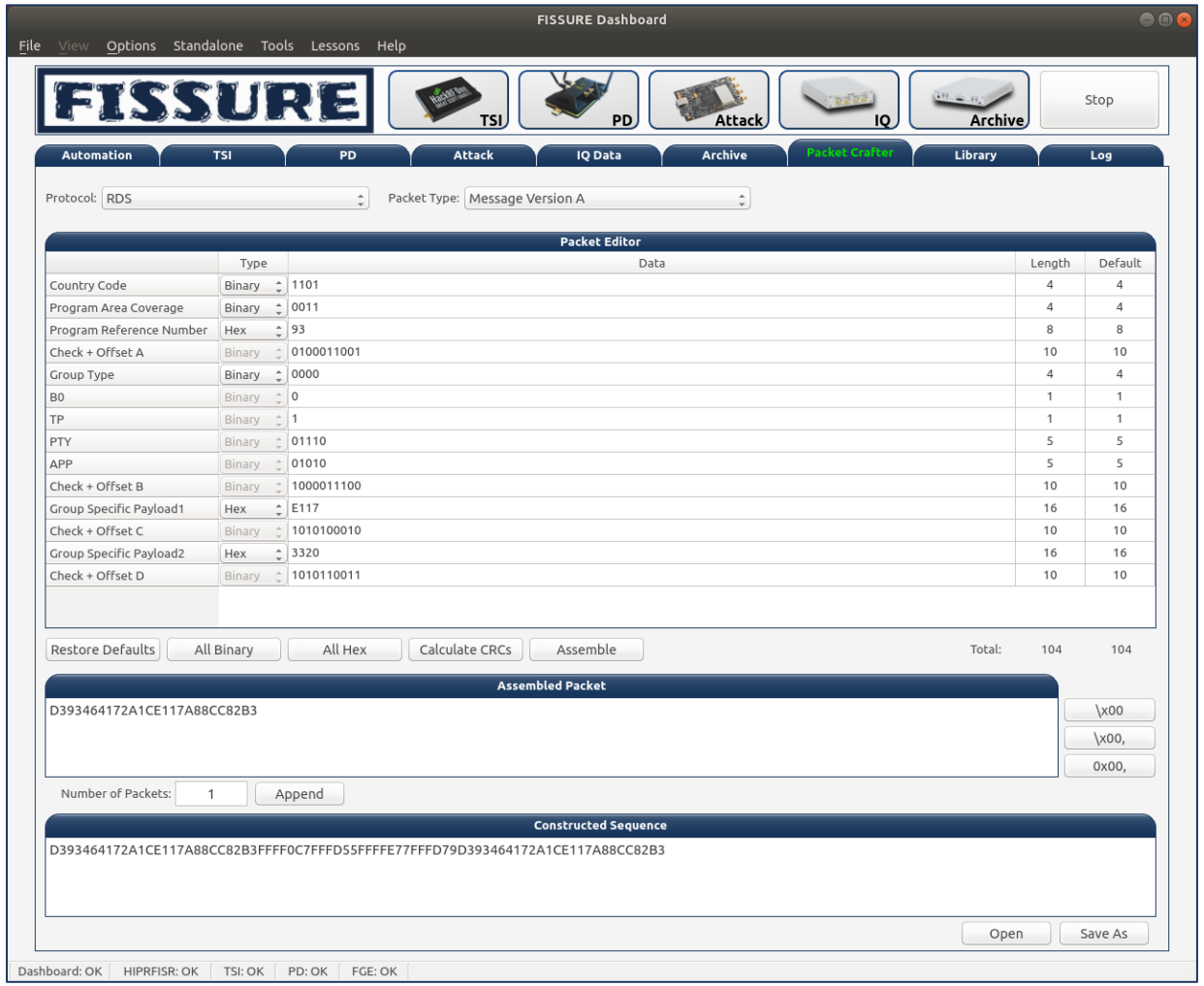
- Download online files
- Create playlists to simulate traffic and test systems
- Future
  - Standardized metadata format: SigMF
  - Create data sets, collections
  - Import from other sources
  - Build playlists of data sets
  - Save/load playlists



Components

Packet Crafting

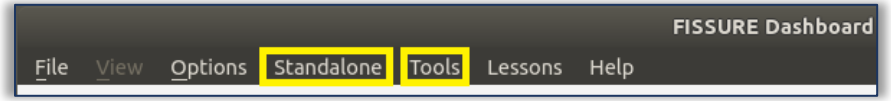
- Assemble custom packets for protocols in library
- Calculate CRC values
- Construct sequences of messages
- Scapy integration for Wi-Fi
- Future
  - More protocols and packet types
  - Quick links to attacks with file sources

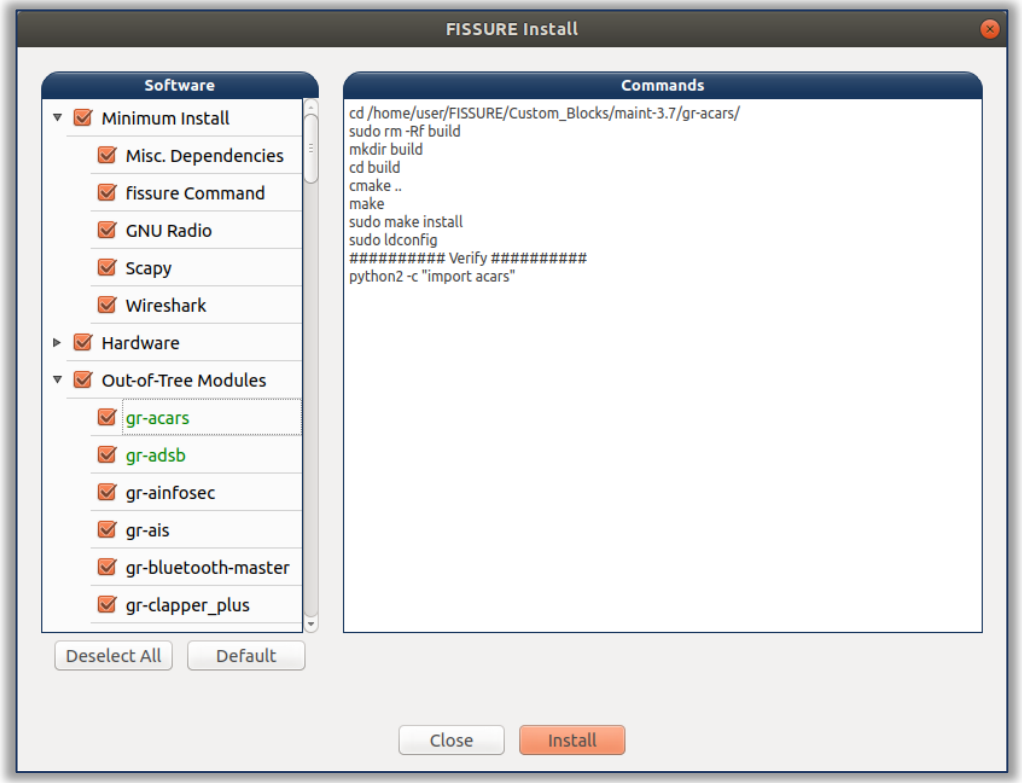


Components

Third-Party Tools

- Standalone flow graphs
  - Favorites that can be edited
  - Separate from the rest of FISSURE
- Third-party tools included with the install
  - Launch directly from the menu
  - Open a terminal with example commands
- Online tools and reference material
  - Maps, calculators, databases, etc.
- Future
  - More protocols, tools
  - Cleaner, more organized installer
  - Docker alternative

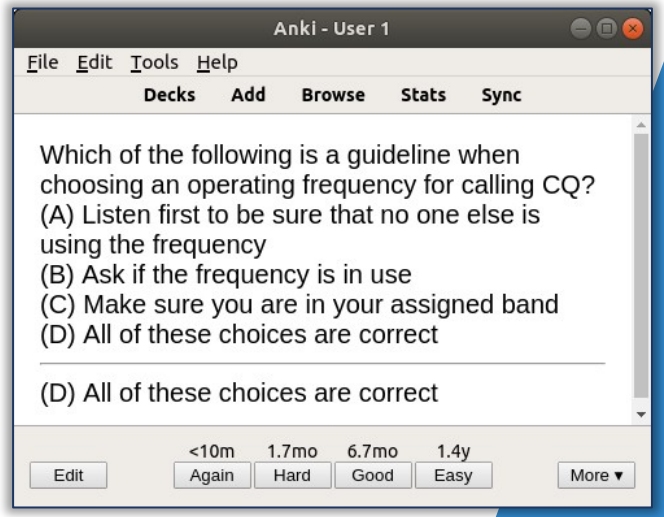




Components

Lessons

- Instructions on how the technology, protocols, and tools work
- Tie the lessons and steps into FISSURE
- Topics like:
  - OpenBTS
  - Lua dissectors
  - Sound eXchange
  - ESP boards
  - Radiosonde tracking
  - RFID
  - Data types
  - Custom GNU Radio blocks
  - TPMS
  - Ham Radio Exams
  - Wi-Fi Attacks
- Future
  - More topics, updates to existing topics
  - Colleges, High schools
  - Clubs, Workshops
  - Hacking/Cyber/RF events



GNU Radio Integration

What is the Role of GNU Radio?

- Running several types of flow graphs, passing data in different ways
  - Detection
  - Inspection
  - Protocol discovery
  - Demodulation
  - Sniffing
  - Attacks
  - Fuzzing
- Changing variable values, loading flow graphs
  - Before runtime
  - While running
  - Running flow graphs with and without GUIs from Python
- Support for 3.7, 3.8, and 3.10 (as separate branches)
- Out-of-Tree modules are submodules pulled from repos
  - Will need to be monitored
- Looking for better and additional ways of using GNU Radio

Roadmap

What's Next?

- The open source governance model has room to evolve
  - Founder-leader > Corporate-backed > Do-ocracy
- Continuing the push for funding avenues
- Establishing more ties with education
- Releasing updated documentation and videos
  - At AIS domain (ainfosec.com)
- Improving existing software
  - Cleaning code, removing bugs, testing more SDRs, expanding lessons
  - Detection, signal conditioning, feature extractor, protocol/emitter classifier
  - Sensor node deployment scheme
- Adding new pieces
  - Not re-inventing the wheel
  - Recursive demodulation, protocol discovery, tracking, vulnerability analysis

Contributing

What can you do?

- Showing your interest is vital
  - Makes for an easier sell to internal/external customers
  - Star the project on GitHub, join the Discord server, follow on Twitter
  - Contact the developers/AIS
- Contributions strengthen the software and saves development time
- Suggestions focus the updates and help others who feel the same way
  - Software tools, hardware suggestions, IQ analysis algorithms, attacks scripts, new operating systems, bugs, improvements
  - New tabs, components, features
- Collaborate with AIS
  - Speeds up FISSURE development and can aid your project at the same time
- Submit a resume to AIS for full-time employment

Any Questions

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Assured Information Security, Inc.

https://github.com/ainfosec/FISSURE