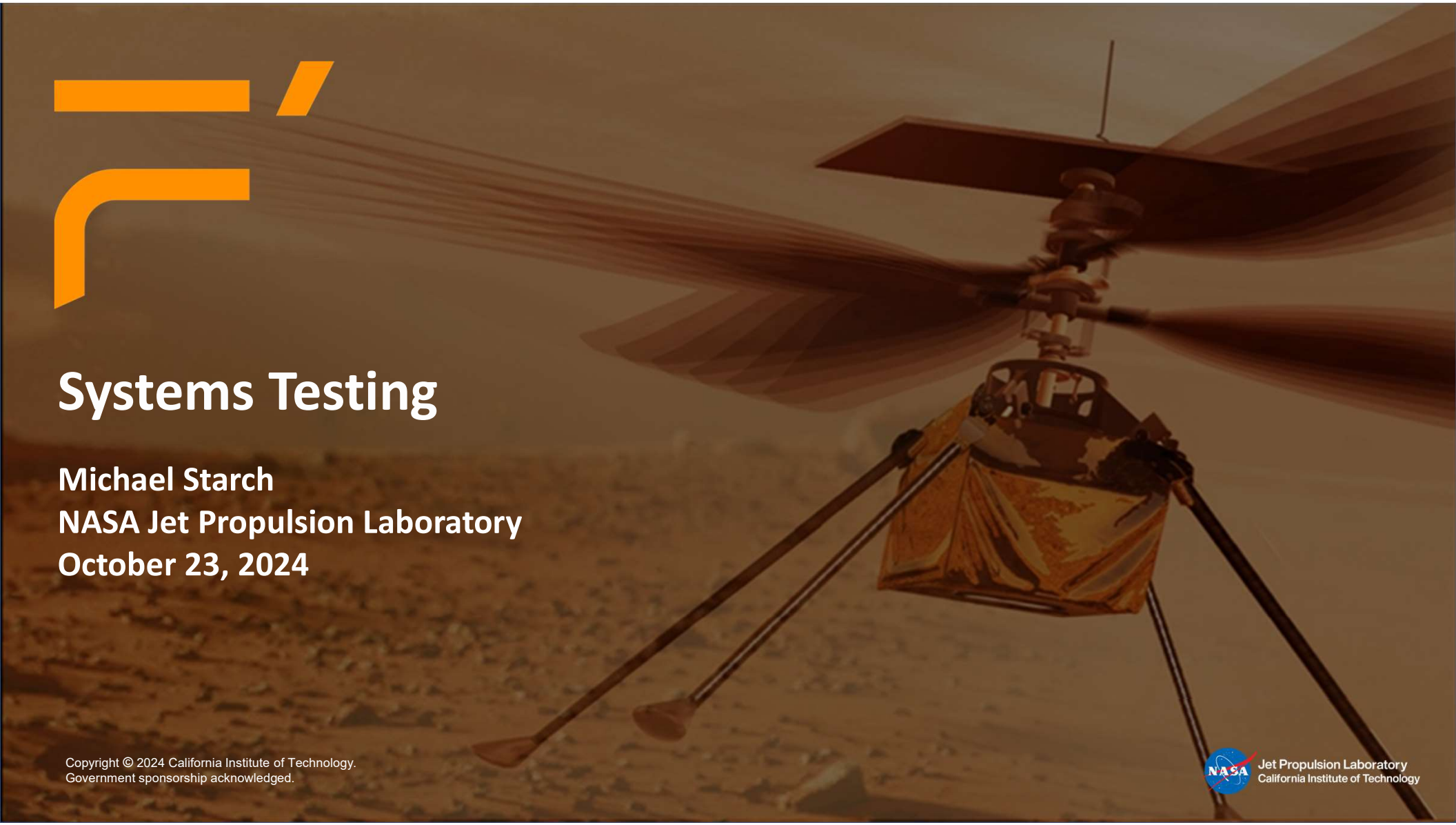

Systems Testing

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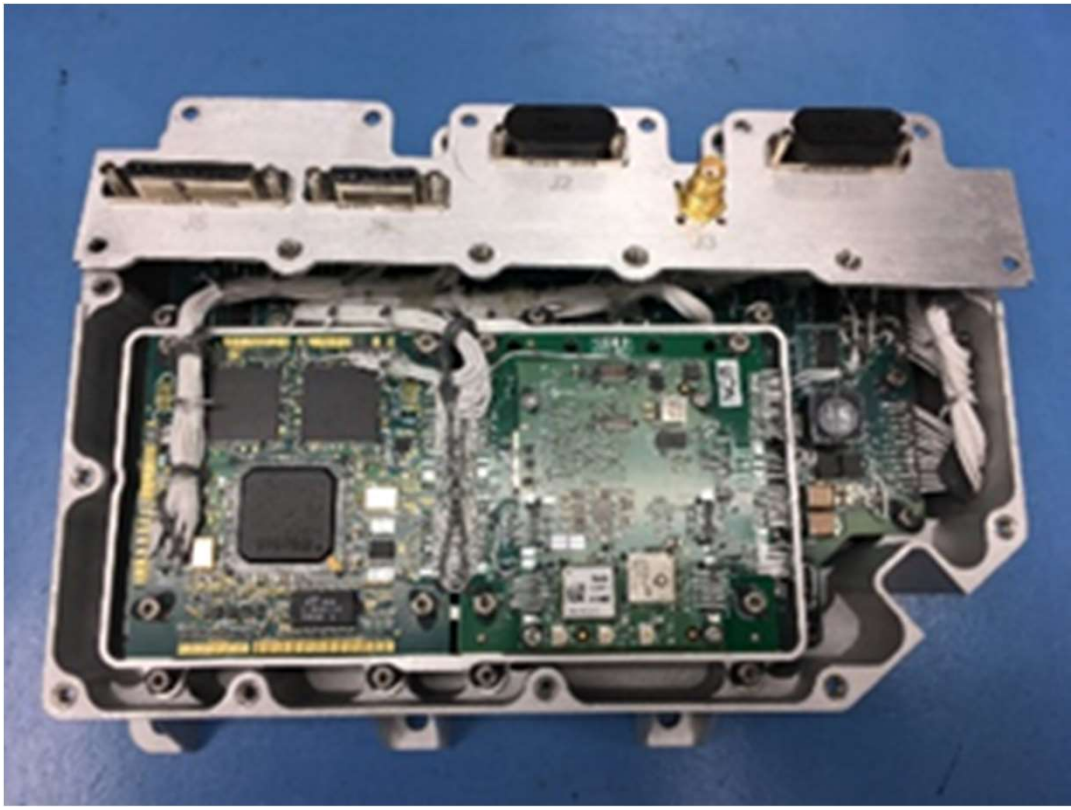
Overview

- Introduction to Systems Testing
  - What is system testing?
  - Why do we do system testing?
  - System testing tools
- Types of System Testing
  - Manual systems testing
  - Automatic system testing
  - Continuous integration
- System Testing with F´

Introduction to System Testing

Systems Testing

- Testing software within the full running system
- Includes flight-like hardware and ground support
- Also called ***integration testing*** and similar to ***regression testing***
- "Test as you fly, fly as you test"



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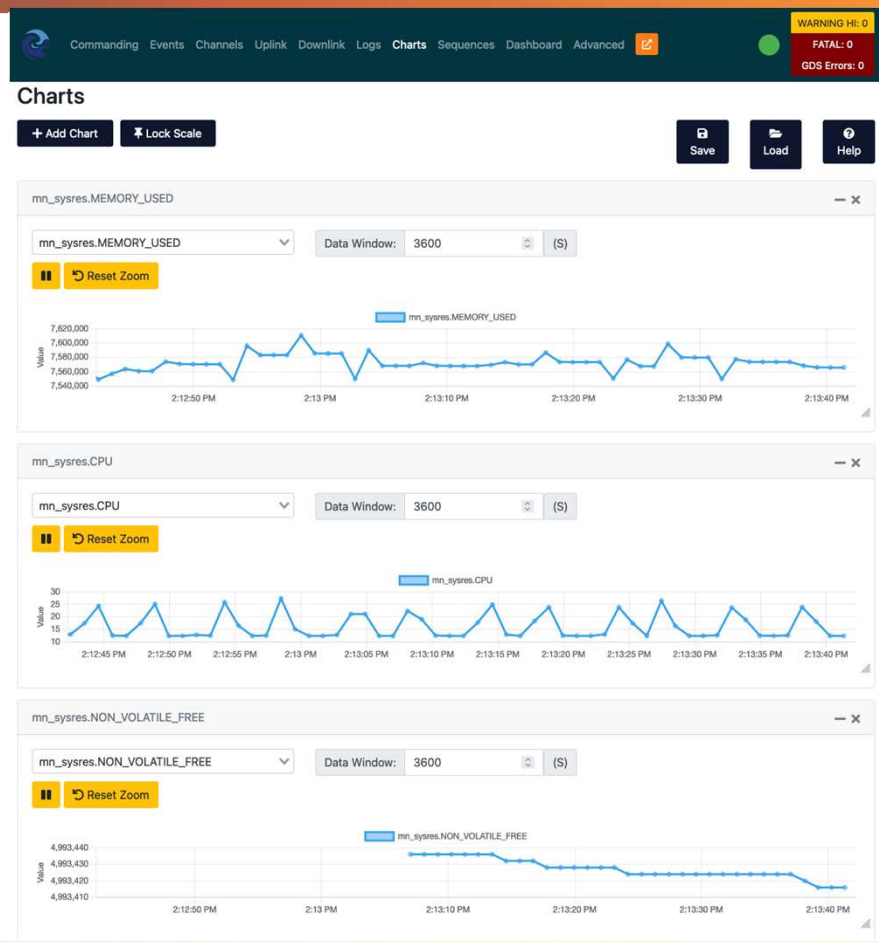
Why Systems Testing?

- A system is more than the sum of its parts
- Some requirements can only be verified at system level
- Hardware operations need testing on hardware
- “Eat our own dog food”

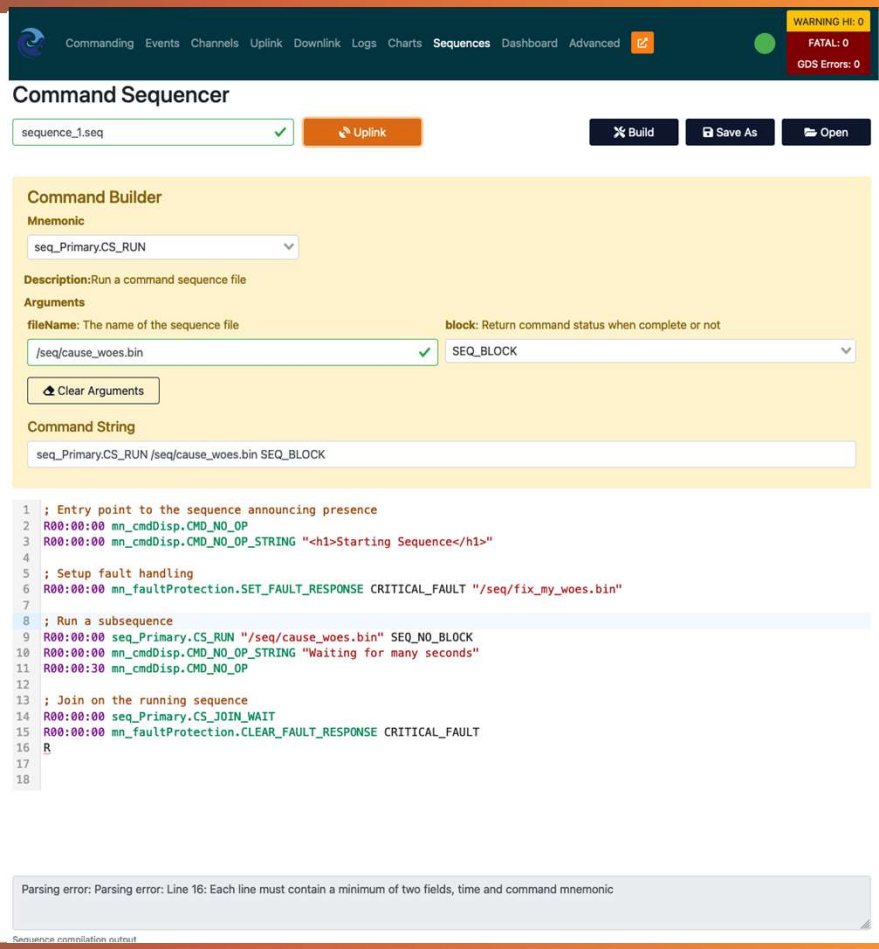


Thundering Herd

Public Domain

System Testing Tools

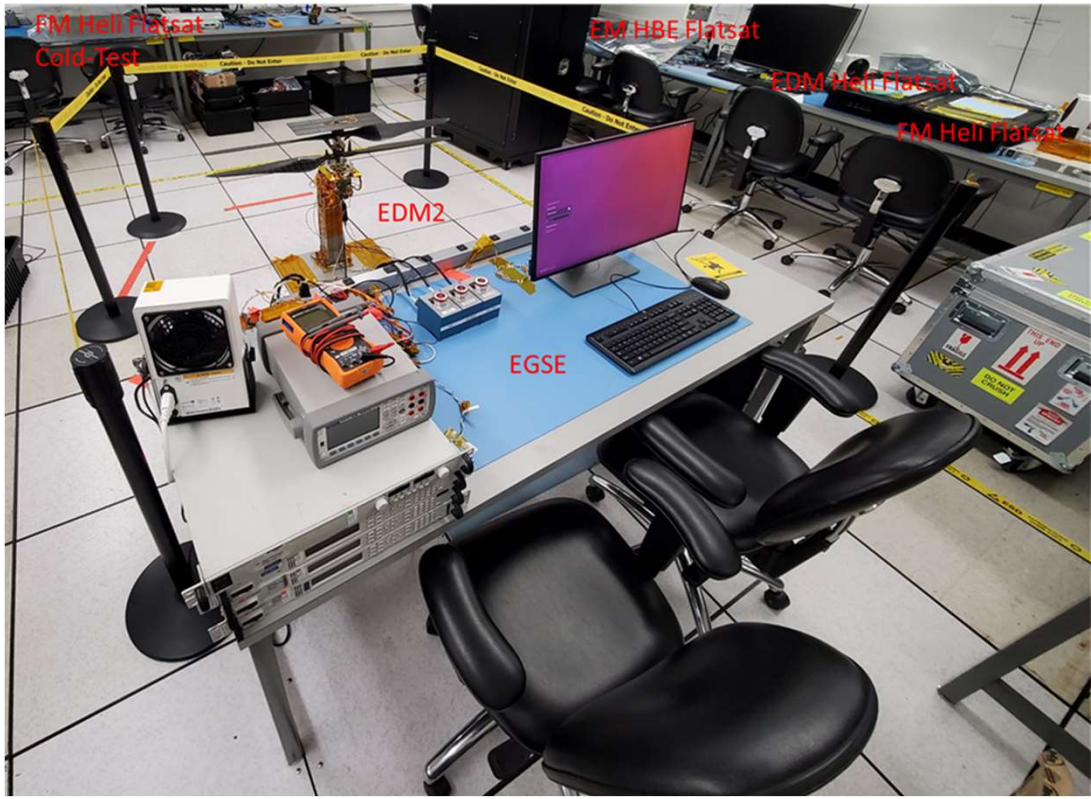
- Ground Data Systems
  - Operate spacecraft from earth
  - May be used to conduct testing
- Testing Frameworks
  - Allow for automated testing
  - Reporting, verification, reproducibility
- Hardware Simulations
  - Allows system testing without physical hardware
- Command Sequences
  - How the flight spacecraft is operated
  - May be used to construct tests



Types of System Testing

Manual Systems Testing

- Operating the spacecraft by-hand to verify requirements
- Running sequences and commands and verifying results
- Ground system is used to send commands
- More complete tests often require full test team



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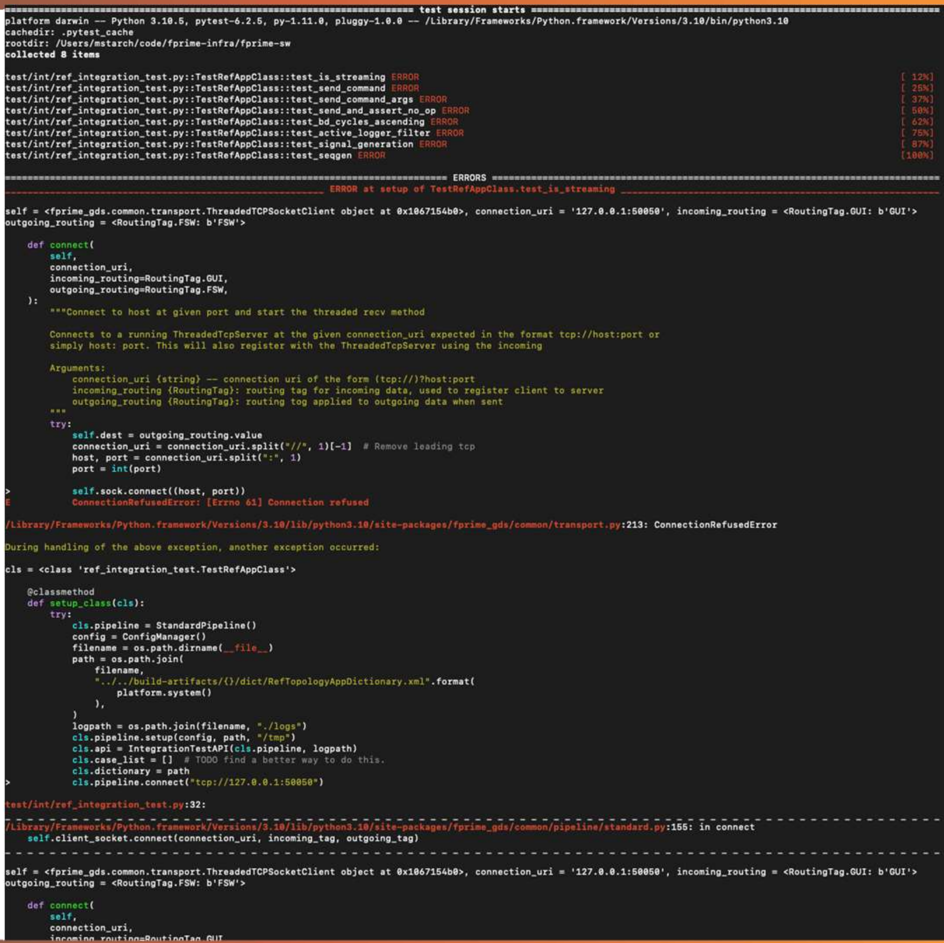
Automated System Testing

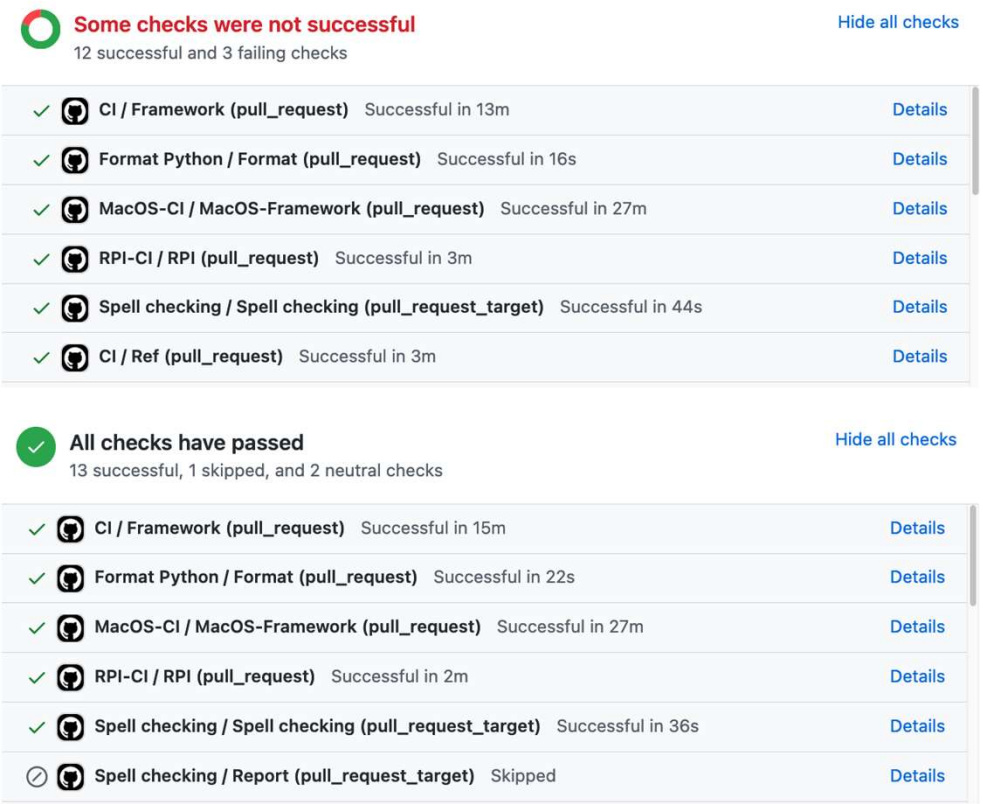
- System testing performed by software
- Uses automated testing support from ground station
- Automatically logs data, results, and verification products
- May not require dedicated test team



```
=================================================================== test session starts ====================================================================
platform darwin -- Python 3.10.5, pytest-6.2.5, py-1.11.0, pluggy-1.0.0 -- /Library/Frameworks/Python.framework/Versions/3.10/bin/python3.10
cachedir: .pytest_cache
rootdir: /Users/mstarch/code/fprime-infra/fprime-sw
collected 8 items

test/int/ref_integration_test.py::TestRefAppClass::test_is_streaming ERROR                                                                           [ 12%]
test/int/ref_integration_test.py::TestRefAppClass::test_send_command ERROR                                                                           [ 25%]
test/int/ref_integration_test.py::TestRefAppClass::test_send_command_args ERROR                                                                      [ 37%]
test/int/ref_integration_test.py::TestRefAppClass::test_send_and_assert_no_op ERROR                                                                  [ 50%]
test/int/ref_integration_test.py::TestRefAppClass::test_bd_cycles_ascending ERROR                                                                    [ 62%]
test/int/ref_integration_test.py::TestRefAppClass::test_active_logger_filter ERROR                                                                   [ 75%]
test/int/ref_integration_test.py::TestRefAppClass::test_signal_generation ERROR                                                                      [ 87%]
test/int/ref_integration_test.py::TestRefAppClass::test_seqgen ERROR                                                                                 [100%]

========================================================================== ERRORS ==========================================================================
_________________________________________________________ ERROR at setup of TestRefAppClass.test_is_streaming _________________________________________________________

self = <fprime_gds.common.transport.ThreadedTCPSocketClient object at 0x1067154b0>, connection_uri = '127.0.0.1:50050', incoming_routing = <RoutingTag.GUI: b'GUI'>
outgoing_routing = <RoutingTag.FSW: b'FSW'>

    def connect(
        self,
        connection_uri,
        incoming_routing=RoutingTag.GUI,
        outgoing_routing=RoutingTag.FSW,
    ):
        """Connect to host at given port and start the threaded recv method

        Connects to a running ThreadedTcpServer at the given connection_uri expected in the format tcp://host:port or
        simply host: port. This will also register with the ThreadedTcpServer using the incoming

        Arguments:
            connection_uri {string} -- connection uri of the form (tcp://)?host:port
            incoming_routing {RoutingTag}: routing tag for incoming data, used to register client to server
            outgoing_routing {RoutingTag}: routing tog applied to outgoing data when sent
        """
        try:
            self.dest = outgoing_routing.value
            connection_uri = connection_uri.split("//", 1)[-1]  # Remove leading tcp
            host, port = connection_uri.split(":", 1)
            port = int(port)

>           self.sock.connect((host, port))
E           ConnectionRefusedError: [Errno 61] Connection refused

/Library/Frameworks/Python.framework/Versions/3.10/lib/python3.10/site-packages/fprime_gds/common/transport.py:213: ConnectionRefusedError

During handling of the above exception, another exception occurred:

cls = <class 'ref_integration_test.TestRefAppClass'>

    @classmethod
    def setup_class(cls):
        try:
            cls.pipeline = StandardPipeline()
            config = ConfigManager()
            filename = os.path.dirname(__file__)
            path = os.path.join(
                filename,
                "../../build-artifacts/{}/dict/RefTopologyAppDictionary.xml".format(
                    platform.system()
                ),
            )
            logpath = os.path.join(filename, "./logs")
            cls.pipeline.setup(config, path, "/tmp")
            cls.api = IntegrationTestAPI(cls.pipeline, logpath)
            cls.case_list = []  # TODO find a better way to do this.
            cls.dictionary = path
>           cls.pipeline.connect("tcp://127.0.0.1:50050")

test/int/ref_integration_test.py:32:
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
/Library/Frameworks/Python.framework/Versions/3.10/lib/python3.10/site-packages/fprime_gds/common/pipeline/standard.py:155: in connect
    self.client_socket.connect(connection_uri, incoming_tag, outgoing_tag)
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

self = <fprime_gds.common.transport.ThreadedTCPSocketClient object at 0x1067154b0>, connection_uri = '127.0.0.1:50050', incoming_routing = <RoutingTag.GUI: b'GUI'>
outgoing_routing = <RoutingTag.FSW: b'FSW'>

    def connect(
        self,
        connection_uri,
        incoming_routing=RoutingTag.GUI
```

Continuous Integration

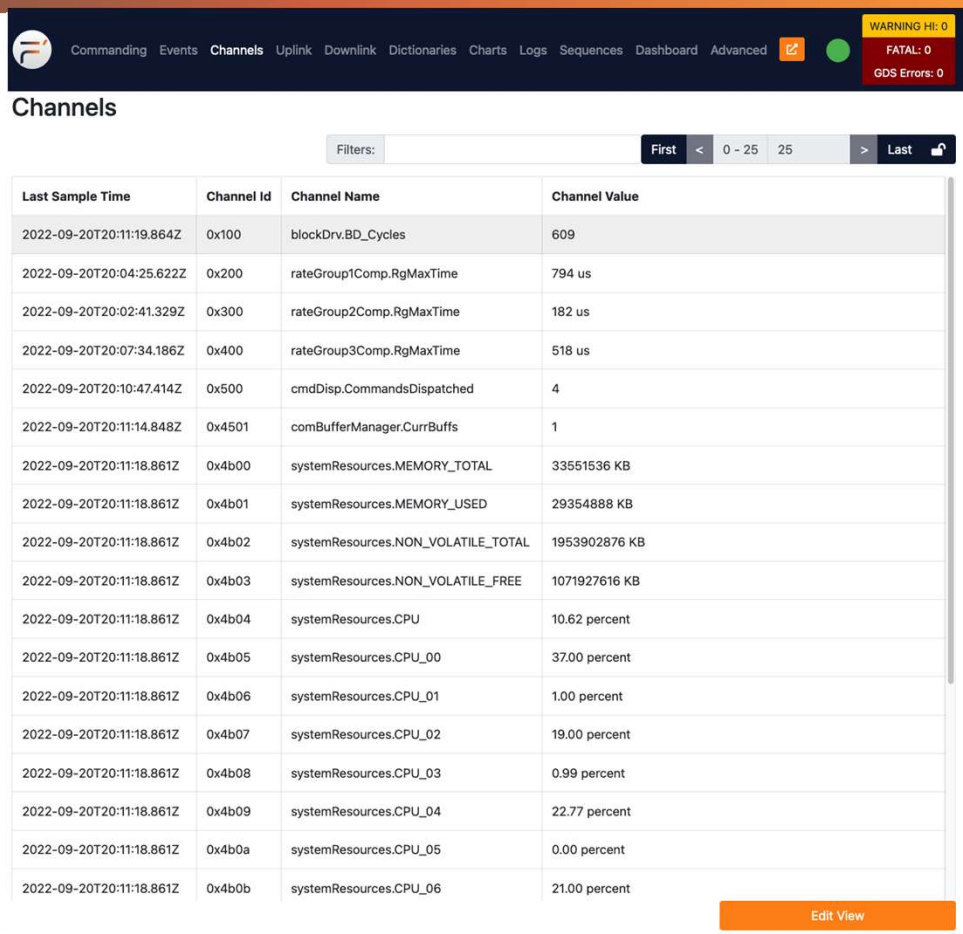
- Extension of automatic system testing
- Triggered by software change request or other criteria
- Requires no human interaction
- Implements full regression testing



System Testing with F´

F´ GDS

- Provides GDS capabilities out-of-the-box for F´ projects
- Designed for system testing early in project development
- Enables developers to:
  - Send commands
  - Receive events and telemetry
  - Uplink and downlink files
  - Design and upload sequences
  - Compose custom dashboards



Last Sample Time	Channel Id	Channel Name	Channel Value
2022-09-20T20:11:19.864Z	0x100	blockDrv.BD_Cycles	609
2022-09-20T20:04:25.622Z	0x200	rateGroup1Comp.RgMaxTime	794 us
2022-09-20T20:02:41.329Z	0x300	rateGroup2Comp.RgMaxTime	182 us
2022-09-20T20:07:34.186Z	0x400	rateGroup3Comp.RgMaxTime	518 us
2022-09-20T20:10:47.414Z	0x500	cmdDisp.CommandsDispatched	4
2022-09-20T20:11:14.848Z	0x4501	comBufferManager.CurrBuffs	1
2022-09-20T20:11:18.861Z	0x4b00	systemResources.MEMORY_TOTAL	33551536 KB
2022-09-20T20:11:18.861Z	0x4b01	systemResources.MEMORY_USED	29354888 KB
2022-09-20T20:11:18.861Z	0x4b02	systemResources.NON_VOLATILE_TOTAL	1953902876 KB
2022-09-20T20:11:18.861Z	0x4b03	systemResources.NON_VOLATILE_FREE	1071927616 KB
2022-09-20T20:11:18.861Z	0x4b04	systemResources.CPU	10.62 percent
2022-09-20T20:11:18.861Z	0x4b05	systemResources.CPU_00	37.00 percent
2022-09-20T20:11:18.861Z	0x4b06	systemResources.CPU_01	1.00 percent
2022-09-20T20:11:18.861Z	0x4b07	systemResources.CPU_02	19.00 percent
2022-09-20T20:11:18.861Z	0x4b08	systemResources.CPU_03	0.99 percent
2022-09-20T20:11:18.861Z	0x4b09	systemResources.CPU_04	22.77 percent
2022-09-20T20:11:18.861Z	0x4b0a	systemResources.CPU_05	0.00 percent
2022-09-20T20:11:18.861Z	0x4b0b	systemResources.CPU_06	21.00 percent

F´ Integration Test Framework

- Framework designed for integration testing with F´ GDS
- Allows users to write automated tests in Python
- Tests dispatch commands and assert on events and telemetry
- Creates excel test logs
- Can be run within continuous integration system

```python
def test_active_logger_filter(self):
    self.set_default_filters()
    try:
        cmd_events = self.api.get_event_pred(severity=EventSeverity.COMMAND)
        actHI_events = self.api.get_event_pred(severity=EventSeverity.ACTIVITY_HI)
        pred = predicates.greater_than(0)
        zero = predicates.equal_to(0)
        # Drain time for dispatch events
        time.sleep(10)

        self.assert_command("cmdDisp.CMD_NO_OP")
        self.assert_command("cmdDisp.CMD_NO_OP")

        time.sleep(0.5)

        self.api.assert_event_count(pred, cmd_events)
        self.api.assert_event_count(pred, actHI_events)

        self.set_event_filter(self.FilterSeverity.COMMAND, False)
        # Drain time for dispatch events
        time.sleep(10)
        self.api.clear_histories()
        self.api.send_command("cmdDisp.CMD_NO_OP")
        self.api.send_command("cmdDisp.CMD_NO_OP")

        time.sleep(0.5)

        self.api.assert_event_count(zero, cmd_events)
        self.api.assert_event_count(pred, actHI_events)
    finally:
        self.set_default_filters()
```

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