



**FHIR® North**  
Canada's FHIR Connectathon



# FHIR Testing with Touchstone

Richard Ettema, AEGIS.net, Inc.



Mohawk College, Hamilton, ON - 26, April 2018 | @TouchstoneTest | @AEGISNet | @techknowman

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## Presented by

- **Name:** Richard Ettema
- **Position:**
  - Lead Consultant, AEGIS.net, Inc.
  - FHIR® Certified Implementer
- **Background:**
  - 34+ years IT industry experience
  - 14+ years leading HIT development/implementation efforts
  - 4+ years contributing to the HL7® FHIR® specification (focus on testing)
  - Sr. Architect / Lead Developer for the Touchstone Project
  - Author of the AEGIS WildFHIR public test server and client



What would happen if airlines practiced “one and done” testing?

*How important is on-going or continuous testing?*





## Question...

*How can implementations based on Industry based Standards like FHIR® ensure they are truly Interoperable with each other?*

- Choice:



Expensive 1-time-before-release conformance testing

- Will most likely uncover previously unknown conformance issues
- Introduce unneeded RISK and additional cost (budget and schedule)

Or,



Moderate expense with continuous testing (**Test Driven Development**)

- Expense decreases over time as testing becomes infused into the development life cycle
- Developers code to the specification as it becomes embedded within each coding cycle
- Budgets and schedule are less risky around conformance

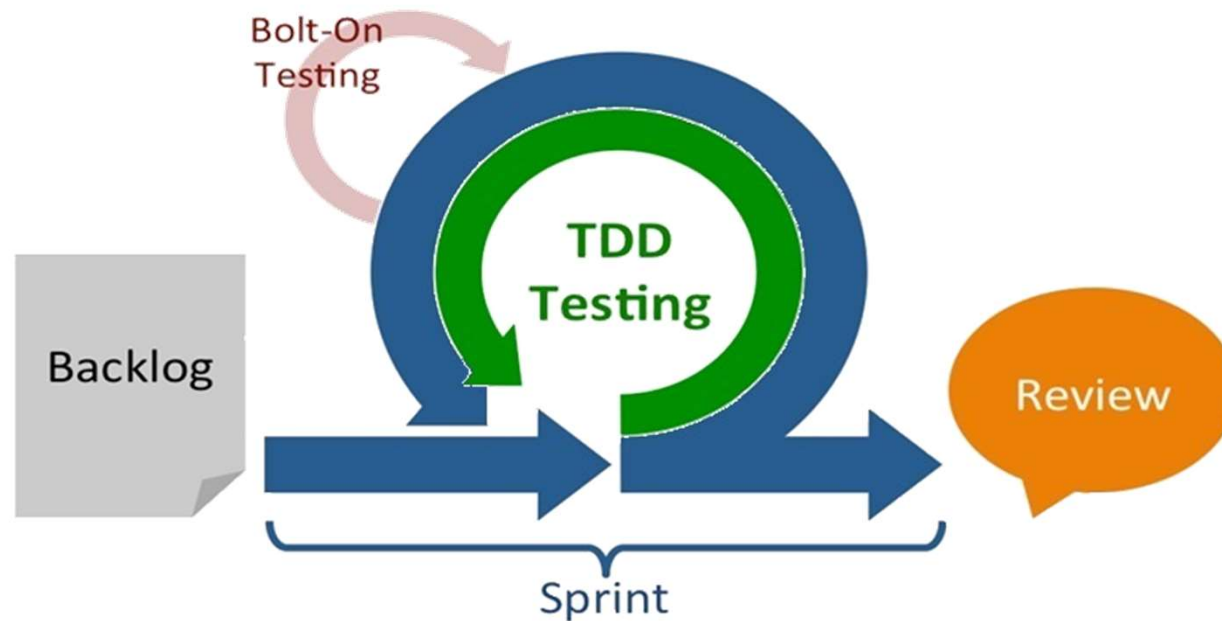


# Test Driven Development Philosophy

- Software development technique that implements short development cycles
- Building on the Agile technique of coding to User Stories; Test Driven Development asks developers to build functionality to pass very specific Test Cases
- Each short development cycle requires that the software pass these Test Cases



# How to integrate TDD into the development lifecycle







## Test Driven Development with FHIR

- To ensure interoperability between applications claiming conformance to the specification, a testing framework has been established within the FHIR specification itself  
<https://www.hl7.org/fhir/STU3/testing.html>
- This framework defines a Test Engine for processing a TestScript resource as a natural language, computable format of a test case
- The TestScript resource is an implementation-agnostic description of tests that allows test engines to evaluate if a FHIR implementation conforms to the FHIR specification  
<https://www.hl7.org/fhir/STU3/testscript.html>



# FHIR Testing Framework – Test Engine Workflow

<http://hl7.org/fhir/STU3/testing.html#execution>

## ★ Pre-Processing

- Determine whether or not the TestScript interactions match the capabilities of the system under test. If supported, execution proceeds; if not, the test engine may halt execution.
- Setup Execution
  - Optional operations that prepare the system under test for subsequent test execution.

## ★ Test Execution

- Execute and record each test's operations and assertions.
- Teardown Execution
  - Optional operations that revert the system under test to its pre-test state.
- Post-Processing
  - Cleanup of test execution data and collection of test results.





## Pre-processing – Capability based testing

- The test engine will use the CapabilityStatement of the system under test to determine how to process a TestScript.
  - ✓ If the TestScript defines the testing of capabilities that the system under test does support, the test engine will continue the workflow process.
  - ❖ If the TestScript defines the testing of capabilities that the system under test does not support, the test engine should allow the TestScript to be skipped, or executed. *Why allow executed?*

***The user may wish to evaluate their test system's functional gaps.***



## Test Execution – Operations and Asserts

- Test execution consists of two action types:
  - **operation**: The FHIR RESTful API interaction to be executed.
  - **assert**: The rule that is evaluated against the results of the operation. If true, the assert passes.
- All FHIR operations, including the extended operations framework, are supported



Key concept: The operation is always executed regardless of whether or not an assert follows.



## A little more about asserts...

- An assert acts on the current, most recently executed operation context
- It states a condition, rule or expression that will be evaluated against that executed operation context

### **Asserts provide support for:**


- Evaluation of both the inbound request or outbound response
- Complex and simple evaluation of HTTP headers and response codes
- Operators for equality, relational comparison, containment, etc.
- Expression language support for XPath, JSONPath and FHIRPath
- Payload comparison to defined fixtures (static or dynamic)
- Payload validation against defined FHIR profile(s)
- *Plus a whole lot more...*



## Introducing Touchstone

- Available as a publicly accessible, cloud-based, Testing as a Service (TaaS) platform
- Provides automated, internet-based interoperability testing of a test system against the HL7<sup>®</sup> FHIR<sup>®</sup> specification
- Tests the capabilities of and interoperability between both FHIR Server and Client implementations
- Is a FHIR Testing Framework conformant FHIR Test Engine and environment for storing and executing TestScripts, and reporting test results




[Touchstone Project](#)

[Test Definitions](#)

# The Touchstone Project

- an AEGIS Developers Integration Lab (DIL) Initiative

[Subscription](#)

[Help and Documentation](#)

[Sign In](#)
[Register](#)


The **Touchstone Project** is an infrastructure as a Service (IaaS) and Testing as a Service (TaaS) Open Access Solution for health information exchange. Touchstone strives to live up to its dictionary definition - a *criterion for determining the quality or genuineness of a thing* - by offering thousands of tests in an easy-to-use system for determining a test system's conformance and interoperability against published specifications, standards, and profiles, including templates and implementation guides.

The Touchstone Project:

- allows for automated, internet-based interoperability testing against the HL7 FHIR specifications and standards.
- tests interoperability with other FHIR Server and FHIR Client implementations.
- has been engineered from the ground up to leverage the new FHIR TestScript resource.
- is a blend between Test-Driven Development (TDD) and Natural Language Processing (NLP) test scripts.
- has been featured at HL7 FHIR Connectionaths and is being leveraged in a continuous testing environment by numerous leading HL7 FHIR implementers.
- plays an active role in the HL7 Conformance Testing community, the HL7 Argonaut Project, and the HSPC Implementation community.


Features include:

- self-registration of user accounts and organizations.
- ability for users to execute FHIR test scripts against test systems with Touchstone serving as the initiator of message exchanges.
- ability for users to initiate message exchanges from their test systems against other peer test systems with Touchstone serving as the intermediary.
- ability to drill down to individual operations and assertions in test execution results.
- ability to save configured sets of test scripts as named "test setups" for re-execution.
- controlled access to test scripts, test systems, and test results at the user, organization, and organization group levels.



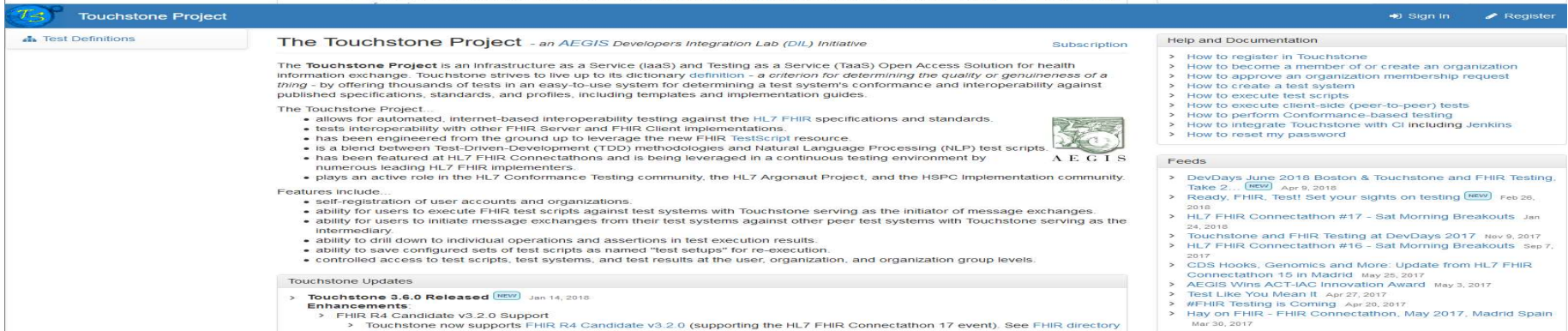
## Touchstone Updates

- > **Touchstone 3.6.0 Released** NEW Jan 14, 2018
- > **Enhancements**
  - > FHIR R4 Candidate v3.2.0 Support
  - > Touchstone now supports FHIR R4 Candidate v3.2.0 (supporting the HL7 FHIR Connectionath 17 event). See FHIR directory



## Feeds

- > DevDays June 2018 Boston & Touchstone and FHIR Testing. Take 2... NEW Apr 9, 2018
- > Ready, FHIR, Test! Set your sights on testing NEW Feb 28, 2018
- > HL7 FHIR Connectionath #17 - Sat Morning Breakouts Jan 24, 2018
- > Touchstone and FHIR Testing at DevDays 2017 Nov 9, 2017
- > HL7 FHIR Connectionath #16 - Sat Morning Breakouts Sep 7, 2017
- > CDS Hooks, Genomics and More: Update from HL7 FHIR Connectionath '15 in Madrid May 25, 2017
- > AEGIS Wins ACT-IAC Innovation Award May 3, 2017
- > Test Like You Mean It Apr 27, 2017
- > #FHIR Testing is Coming Apr 20, 2017
- > Hay on FHIR - FHIR Connectionath, May 2017, Madrid Spain Mar 30, 2017






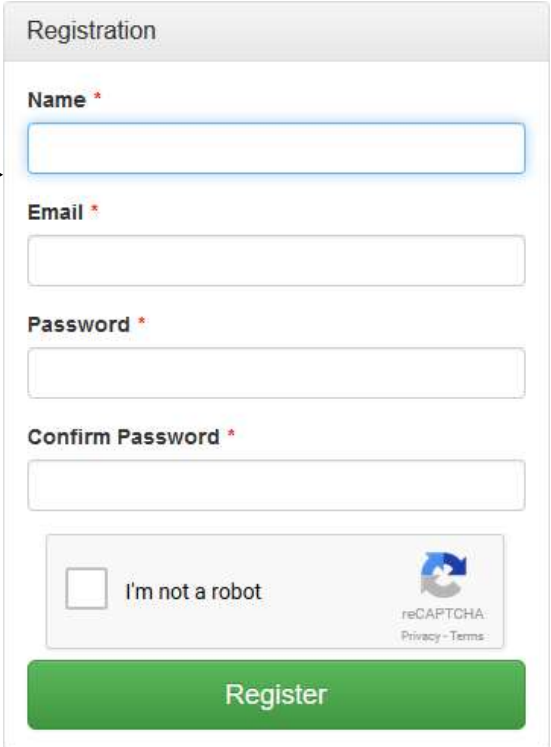
## Getting started with Touchstone

- Anyone can access the Touchstone landing page and view the publicly available test definitions (TestScripts)
- Registration and acceptance of the user agreement must be completed before any other features become accessible including test execution
- Every user must belong to an organization
- Organizations may have 1 or more registered users in Touchstone (based on subscription level)



## Getting started – user registration

- If you are not yet registered in Touchstone, select the Register menu item in the upper-right navigation bar  →
- Enter your
  - Touchstone user name
  - Valid email address (for notifications)
  - Password (twice for confirmation)
- Select “I’m not a robot”
- Click “Register”



Registration

Name \*

Email \*

Password \*

Confirm Password \*

☐ I'm not a robot

reCAPTCHA  
Privacy - Terms

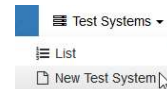
Register





## Getting started – create a test system

- A test system must be available for test executions
- You can use any existing, publicly accessible test system, or
- Create your own test system:
  - Select the “New Test System” menu item
  - Fill out the required fields
  - Change the privacy settings if desired



**New Test System** Create

Name

Specification <sup>\*</sup>

Formats Supported <sup>\*</sup> ☒ JSON ☒ XML

Base URL <sup>\*</sup>

IP Addresses (comma-separated)

Requires ☐ OAuth2

Organization <sup>\*</sup>

Can be viewed by ☐ Me ☐ My organization ☐ My organization groups ☒ Everyone

Can be executed against by ☐ Me ☒ My organization ☐ My organization groups ☐ Everyone

Can be modified by ☐ Me ☒ My organization ☐ My organization groups ☐ Everyone

☒ Allow Touchstone to pull capability statement once a day (recommended)

Available Profiles

Supported Profiles <sup>\*</sup>

Create



## Getting started – Test Setup

- Test executions are based on Test Setups
- Steps:
  - Select one or more Test Definitions (TestScripts)
  - Click the Create Test Setup link
  - The Test Setup UI will be displayed
  - Select the Test System(s)
  - Fill in any other required fields
  - Click Execute...

Test Definitions - /FHIR3-0-1-Basic/P-R/Patient

Name:  ☐ All ☒ Test Scripts ☐ Fixtures

<input type="checkbox"/> Test Script	Version	History	Description
<input type="checkbox"/> /FHIR3-0-1-Basic/P-R/Patient/Client Assigned Id/Patient-client-id-json	1		FHIR Server F Resource Id - Support for rel Search is also
<input type="checkbox"/> /FHIR3-0-1-Basic/P-R/Patient/Client Assigned Id/Patient-client-id-xml	1		FHIR Server F Resource Id - Support for rel Search is also
<input type="checkbox"/> /FHIR3-0-1-Basic/P-R/Patient/Server Assigned Id/Patient-server-id-json	1		FHIR Server F Resource Id - Support for rel Search is also
<input type="checkbox"/> /FHIR3-0-1-Basic/P-R/Patient/Server Assigned Id/Patient-server-id-xml	1		FHIR Server F Resource Id - Support for rel Search is also

**Test Definitions**

- FHIR3-0-1-Connectathon15
- FHIR3-0-1-Basic
  - A-C
  - D-H
  - I-O
  - P-R
    - Patient**
      - Client Assigned Id
      - Server Assigned Id



# Getting started – Test Execution

Analytics

Conformance

Test Executions

**Test Execution**

History

Exchanges

Test Setups

Test Setup

List

Test Definitions

## Test Execution

Exec Id: 20170503120548685

Start Time: 05/03/2017 12:05:48PM

End Time:

Status: Running

Duration: 8.138s

Test Scripts: 4

Test Setup: FHIR3-0-1-Basic-P-R-Patient--All

Executed By: Afsheen Eeshat

Organization: aegis testing

Origin: Touchstone

Destination: AEGIS.net, Inc. - WildFHIR FHIR-3-0-1 <http://wildfhir.aegis.net/fhir3-0-1>

28 tests

9 passes

0 failures

0 skipped

1 running

0 waiting

18 not started

32% successful

Refresh

Test Script Execution	Version	Latest	Spec	Description	Status	Start	End	Duration	Passed	Tests
/FHIR3-0-1-Basic/P-R/Patient/Client Assigned Id/Patient-client-id-json	1	1	FHIR 3.0.1	FHIR Server Patient Basic Operation Tests - JSON - Client Assigned Resource Id - Create, Delete, History, Read, Search, Update, Vread. Support for referenced resource type Organization Update, Delete and Search is also required.	Passed	05/03/2017 12:05:48PM	05/03/2017 12:05:54PM	5.840s	7 of 7	<div></div>
/FHIR3-0-1-Basic/P-R/Patient/Client Assigned Id/Patient-client-id-xml	1	1	FHIR 3.0.1	FHIR Server Patient Basic Operation Tests - XML - Client Assigned Resource Id - Create, Delete, History, Read, Search, Update, Vread. Support for referenced resource type Organization Update, Delete and Search is also required.	Running	05/03/2017 12:05:54PM		2.192s	2 of 7	<div></div>
/FHIR3-0-1-Basic/P-R/Patient/Server Assigned Id/Patient-server-id-json	1	1	FHIR 3.0.1	FHIR Server Patient Basic Operation Tests - JSON - Server Assigned Resource Id - Create, Delete, History, Read, Search, Update, Vread. Support for referenced resource type Organization Create, Delete and Search is also required.	Not Started				0 of 7	<div></div>
/FHIR3-0-1-Basic/P-R/Patient/Server Assigned Id/Patient-server-id-xml	1	1	FHIR 3.0.1	FHIR Server Patient Basic Operation Tests - XML - Server Assigned Resource Id - Create, Delete, History, Read, Search, Update, Vread. Support for referenced resource type Organization Create, Delete and Search is also required.	Not Started				0 of 7	<div></div>



# Getting started – TestScript Execution

## Test Script Execution - /FHIR3-0-1-Basic/P-R/Patient/Client Assigned Id/Patient-client-id-json

[← To Analytics](#) [← To Test Execution](#)

**Exec Id:** 20171023043322929  
**Start Time:** 10/23/2017 04:33:23PM  
**End Time:** 10/23/2017 04:33:30PM  
**Status:** Passed  
**Duration:** 7.495s  
**Version:** 4  
**Specification:** FHIR 3.0.1 - STU3 Official

**Description:** FHIR Server Patient Basic Operation Tests - JSON - Client Assigned Resource Id - Create, Delete, History, Read, Search, Update, Vread. Support for referenced resource type Organization Update, Delete and Search is also required.

**Executed By:** Richard Ettema  
**Organization:** AEGIS.net, Inc.  
**Origin:** Touchstone  
**Destination:** AEGIS.net, Inc. - WildFHIR FHIR-3-0-1 <http://wildfhir.aegis.net/fhir3-0-1>  
**Test Script:** /FHIR3-0-1-Basic/P-R/Patient/Client Assigned Id/Patient-client-id-json



Setup [\[show\]](#) Duration: 0.597s Status: Passed

### Tests

Test Name	Description
Test: Step1-CreateNewPatient	Create a new Patient in JSON format where the client assigns the resource in JSON format, an OperationOutcome resource in JSON format.
Test: Step2-ReadPatient	Read the Patient in JSON format created in step 1. The expected response is a Patient resource in JSON format.

### Interactions

	100% passed	Pass	Fail	Other	Total
Summary	<div></div>	11	0	0	11
delete Organization	<div></div>	1	0	0	1
updateCreate Organization	<div></div>	1	0	0	1
delete Patient	<div></div>	2	0	0	2
history-instance Patient	<div></div>	1	0	0	1
read Patient	<div></div>	2	0	0	2
search-type Patient	<div></div>	1	0	0	1
update Patient	<div></div>	1	0	0	1
updateCreate Patient	<div></div>	1	0	0	1
vread Patient	<div></div>	1	0	0	1

Touchstone Project - /FHIR3-0-1-Basic/P-R/Patient/Client Assigned Id/Patient-client-id-json

<https://touchstone.aegis.net/touchstone/testscript?id=21c07d849515340>

**Test Script**

**Name** /FHIR3-0-1-Basic/P-R/Patient/Client Assigned Id/Patient-client-id-json

**Description** FHIR Server Patient Basic Operation Tests - JSON - Client Assigned Resource Id - Create, Delete, History, Read, Search, Update, Vread. Support for referenced resource type Organization Update, Delete and Search is also required.

**Version** 4 **Latest** 4

**Content**

```
<?xml version="1.0" encoding="UTF-8"?>
<TestScript xmlns="http://hl7.org/fhir">
  <id value="Patient-client-id-json"/>
  <url value="http://wildfhir.aegis.net/fhir3-0-1/TestScript">
    <name value="FHIR Server Patient Basic Operation Tests - JSON - Client Assigned Resource Id - Create, Delete, History, Read, Search, Update, Vread. Support for referenced resource type Organization Update, Delete and Search is also required."/>
    <status value="active"/>
    <date value="2017-07-02"/>
  </url>
</TestScript>
```

	Status	Duration
a content of either the created Patient	<span>Passed</span>	1.178s
source in JSON format.	<span>Passed</span>	0.342s



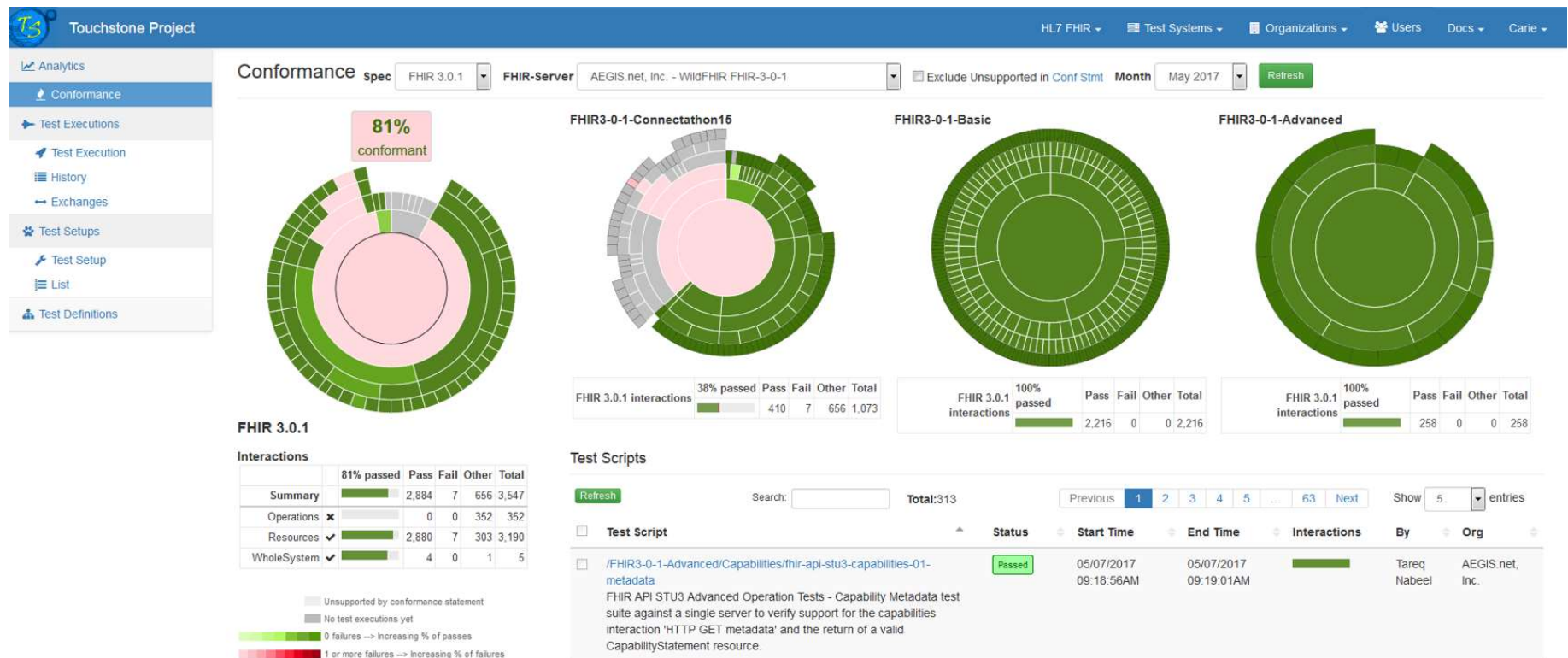
## Getting started – TestScript Execution – Results

Action	Description	Status	Duration	Details
→ Operation	<b>read</b> - Patient  Origin: Touchstone Destination: AEGIS.net, Inc. - WildFHIR FHIR-3-0-1http://wildfhir.aegis.net/fhir3-0-1	404 Not Found	0.132s	Type: read Resource: Patient URL: http://wildfhir.aegis.net/fhir3-0-1/Patient/1 Description: Patient read operation with no sent HTTP Headers and no sent request URL parameters defined. Definition: ... Request: Method: GET Path: http://wildfhir.aegis.net/fhir3-0-1/Patient/1 Response: Status: HTTP/1.1 404 Not Found Headers: Connection keep-alive Content-Length 911 Content-Type application/fhir+xml; charset=utf-8 Date Fri, 09 Jun 2017 13:52:55 GMT Server WildFly/8 X-Powered-By Undertow/1 Response: Body
→ Assert	Response code is 200	Failed	0.000s	The actual value "404" did not match the expected value "200" for response code in response. Description: Confirm that the returned HTTP status is 200(OK). Definition: { "description" : "Confirm that the returned HTTP status is 200(OK).", "responseCode" : "200", "direction" : "response" }





# Conformance Analytics are built in





# Test Execution History easily accessible

## Test Executions

Test Setup:  Executed By Org:

Test System:   Status:

Executed: ☒ By Me ☐ By My Org ☐ With My Org ☐ By Everyone

...

Records 1 - 10 of 192

Page Size:

Start Time	Test Setup	Origin	Destination	By	Org	Delete	Stop	Status	End Time	Duration	Passed	Tests
10/23/2017 04:33:22PM	FHIR3-0-1-Basic-P-R-Patient--All	Touchstone	AEGIS.net, Inc. - WildFHIR FHIR-3-0-1 <input type="button" value="C"/> <a href="http://wildfhir.aegis.net/fhir3-0-1">http://wildfhir.aegis.net/fhir3-0-1</a>	Richard Ettema	AEGIS.net, Inc.	<input checked="" type="button" value="X"/>		<input type="button" value="Passed"/>	10/23/2017 04:33:51PM	28s	28 of 28	<div></div>
10/13/2017 02:56:03PM	FHIR1-0-2-Basic-P-R--tests	Touchstone	AEGIS.net, Inc. - WildFHIR FHIR-3-0-1 <input type="button" value="C"/> <a href="http://wildfhir.aegis.net/fhir3-0-1">http://wildfhir.aegis.net/fhir3-0-1</a>	Richard Ettema	AEGIS.net, Inc.	<input checked="" type="button" value="X"/>		<input type="button" value="Failed"/>	10/13/2017 02:57:10PM	1m 6s	58 of 140	<div></div>
10/13/2017 02:55:19PM	FHIR1-0-2-Basic-D-H-DiagnosticOrder--tests	Touchstone	AEGIS.net, Inc. - WildFHIR FHIR-3-0-1 <input type="button" value="C"/> <a href="http://wildfhir.aegis.net/fhir3-0-1">http://wildfhir.aegis.net/fhir3-0-1</a>	Richard Ettema	AEGIS.net, Inc.	<input checked="" type="button" value="X"/>		<input type="button" value="Failed"/>	10/13/2017 02:55:21PM	2s	0 of 28	<div></div>
10/13/2017 02:39:42PM	FHIR3-0-1-Connectathon16--connectathon-16-patient-fhirclient-03-read-json	AEGIS.net, Inc. - WildFHIR FHIR-3-0-1 <input type="button" value="C"/> <a href="http://wildfhir.aegis.net">wildfhir.aegis.net</a>	AEGIS.net, Inc. - WildFHIR FHIR-3-0-1 <input type="button" value="C"/> <a href="http://wildfhir.aegis.net/fhir3-0-1">http://wildfhir.aegis.net/fhir3-0-1</a>	Richard Ettema	AEGIS.net, Inc.	<input checked="" type="button" value="X"/>		<input type="button" value="Passed"/>	10/13/2017 02:42:11PM	2m 28s	1 of 1	<div></div>





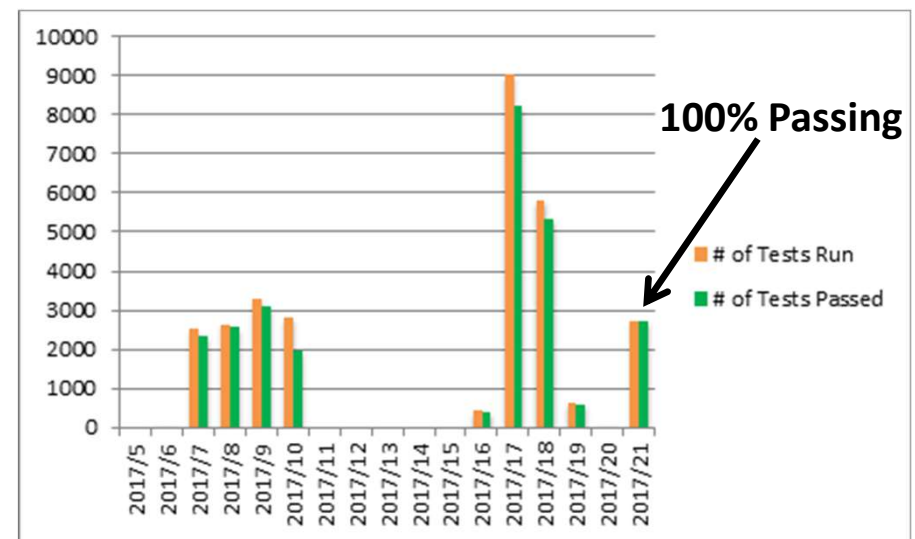
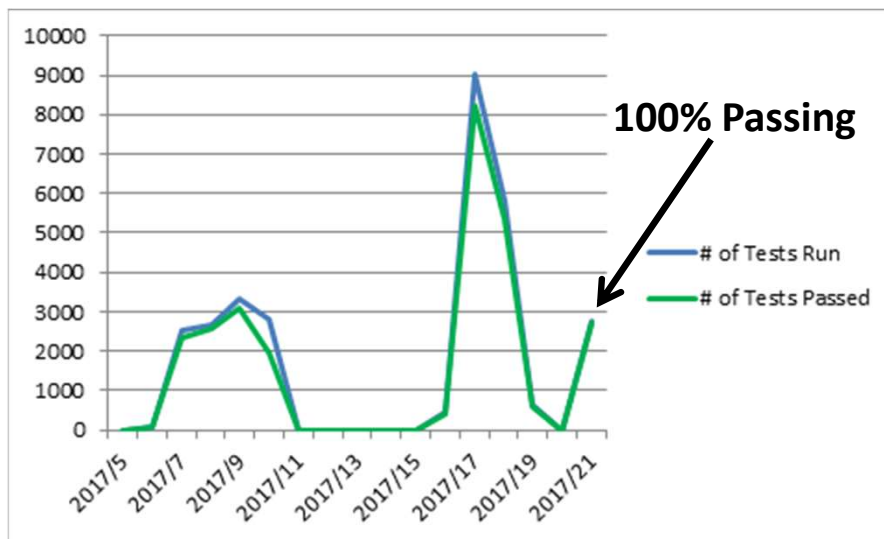
## Evidence-Based Quality Assurance

- Continuous Testing against a defined standard ensures ‘no surprises’ when publishing new releases
- Continuous Testing generates data used in analytics which can
  - show patterns and predict trouble areas
  - pinpoint issues in development
  - help show continuous interoperability to your customers, highlighting your competence and reliability
  - provide metrics that can tell the story about problem areas or where there is little volatility



## Benefits of using Touchstone – A Real world example

- The following graphs show the progression of testing for an organization using the Touchstone production environment.



*\*Data used with organization's permission*



## How can your organization use Touchstone?

- First and foremost, Touchstone can help your organization with FHIR conformance testing

### Touchstone

- maintains test suites for multiple FHIR versions
- includes basic, advanced, and various Connectathon scenarios
- tracks and maintains test results allowing organizations to view and share those results as they wish
- provides the opportunity to validate conformance based on the test system's CapabilityStatement their server actually issues; you test for what you assert your system is capable of doing



## How can your organization use Touchstone?

- Second, organizations can utilize the Touchstone test suites during software build cycles

### Touchstone

- provides thorough logging of requests and responses allowing developers and testers greater insight into why a test may have failed
- provides embedded, version specific links to the specification within the test execution results to help narrow focus
- APIs are available to help automate testing



## How can your organization use Touchstone?

- And, organizations have the opportunity to write and run their own TestScripts within Touchstone
  - Build your own scripts for: conformance, regression, build verification and validation, program support, etc.
    - Can be uploaded to Touchstone by AEGIS upon approval or by you based on your subscription level
    - **Touchstone IDE / TestScript Editor – see me for a demo**
  - Governing organizations can build Implementation Guide test suites and house them in Touchstone to facilitate conformance testing

★ AEGIS offers Multi-day tutorials and training on Touchstone, FHIR Testing and TestScript Authoring

<https://touchstone.aegis.net/touchstone/features#Training>



## Discussion (Q & A)





**FHIR® North**  
Canada's FHIR Connectathon



# Thank you!

See you at the FHIR Testing table!

Mohawk College, Hamilton, ON - 26, April 2018 | @TouchstoneTest | @AEGISNet | @techknowman

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