2019

Rapid Construction of Accurate Automatic Alert Handling System

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Rapid Construction of Accurate Automatic Alert Handling System

Overview

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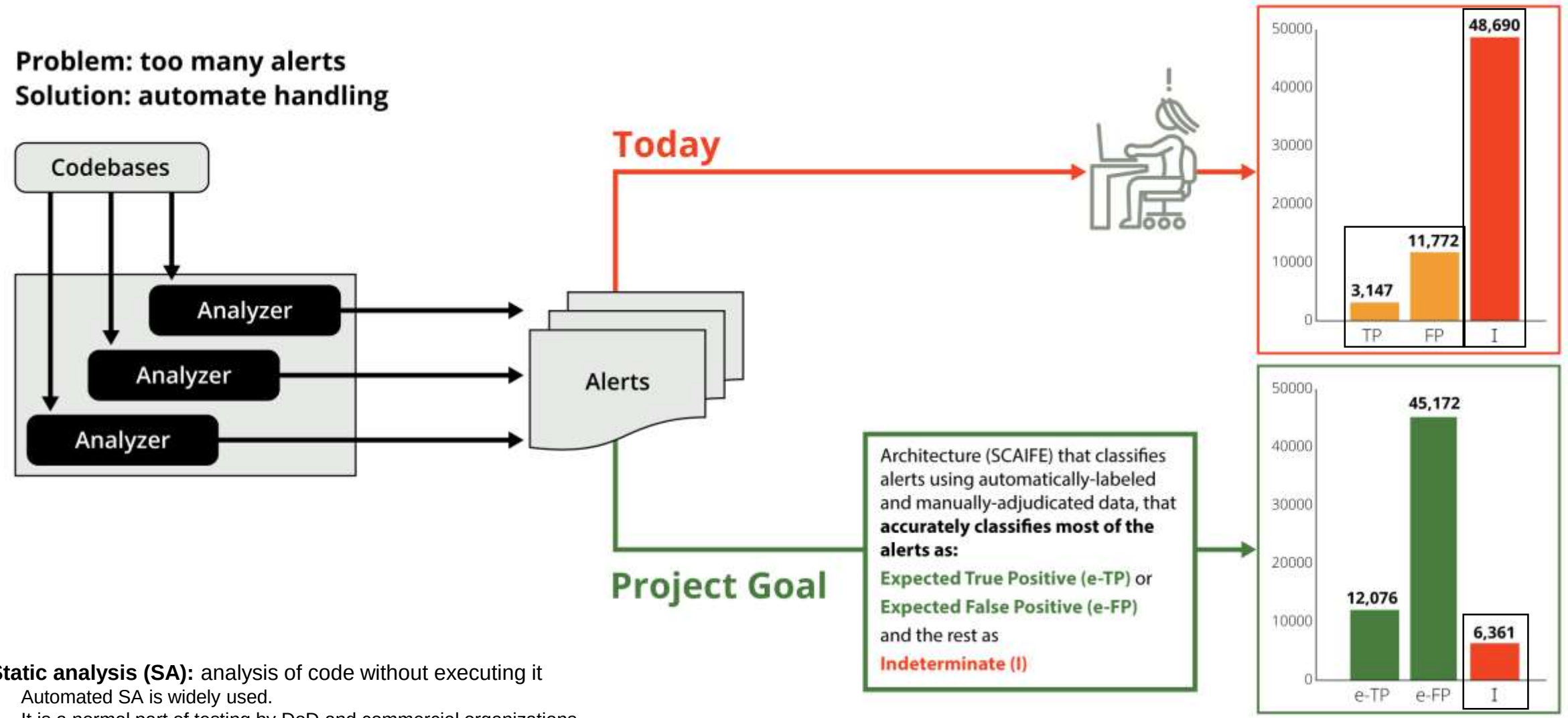
FY18-19 Artifacts

Status of SCAIFE

Impacts Time Frame

Overview



Static analysis (SA): analysis of code without executing it

- Automated SA is widely used.
- It is a normal part of testing by DoD and commercial organizations.

In this presentation, *alert* represents alert, meta-alert, or alertCondition as defined in our previous publications.

FY16-19 Static Analysis Alert Classification Research

Goal: Enable **practical** automated alert classifier use so all alerts can be addressed.

FY16

- Issue addressed: classifier accuracy
- Novel approach: **multiple static analysis tools as features**
- Result: increased accuracy

FY17

- Issue addressed: **too little labeled data** for accurate classifiers for some conditions (e.g., CWEs, coding rules)
- Novel approach: **use test suites to automate the production of labeled** (True/False) **alert archives* for many conditions**
- Result: high precision for more conditions

FY18-19

- Issue addressed: **little use of automated alert classifier technology** (requires $$, data, experts)
- Novel approach: **develop extensible architecture with novel test-suite data method**
- Result: **enabled wider use of classifiers (less $$, data, experts)** with extensible architecture, API, software to instantiate architecture, and adaptive heuristic research

* By the end of FY18, ~38K new labeled (T/F) alerts from eight SA tools on the Juliet test suite (vs. ~7K from CERT audit archives over 10 years)

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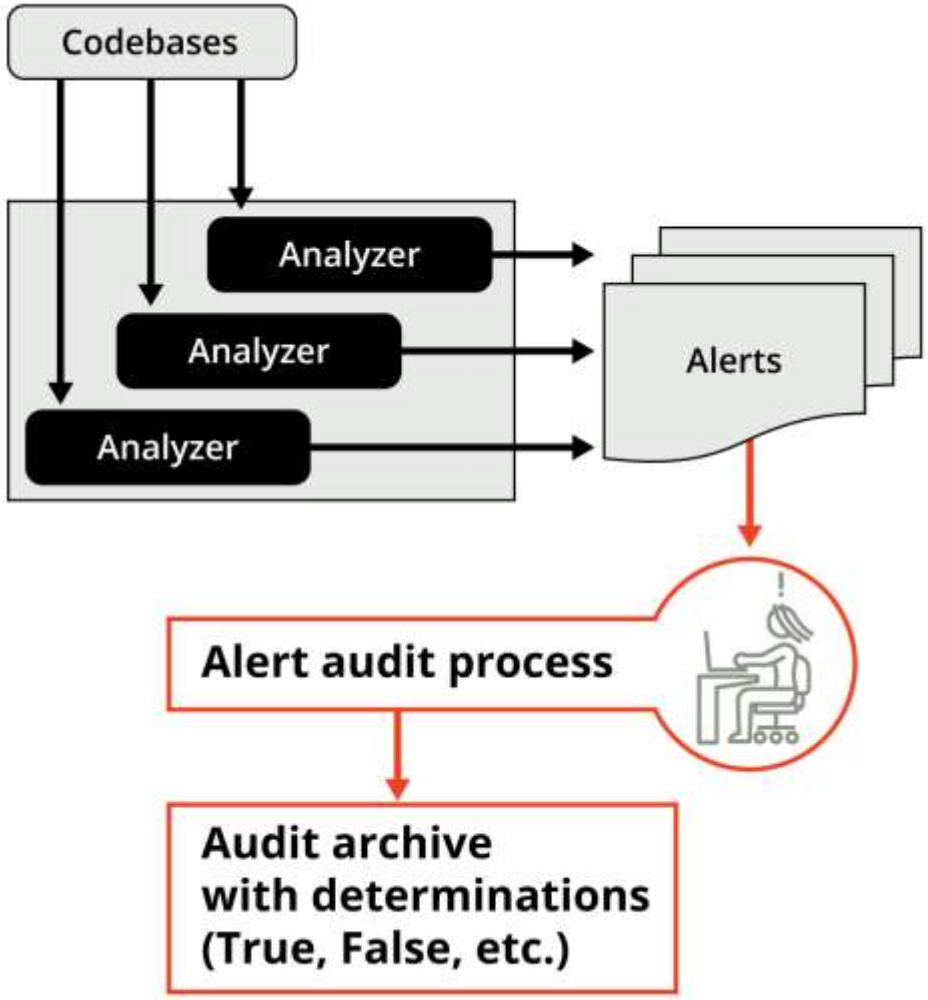
FY18-19 Artifacts

SEI SCALe Framework: Background



Static Analysis Alert Auditing Framework
Developed by the SEI for ~10 years.

- GUI front end to examine alerts and associated code
- Alert adjudications (true, false) stored in database

Use for Research Projects

- Enhance with features for research.
- Collaborators use it on their codebases.
- Researchers analyze audit data.

SCAIFE Definitions

SCAIFE is **a modular architecture that enables static analysis alert classification** plus advanced prioritization.

- The **SCAIFE API** defines interfaces between the modular parts.
- **SCAIFE systems** are software systems that instantiate the API.
- Our SCAIFE system releases include a SCALe module plus much more.

SCAIFE = Source Code Analysis Integrated Framework Environment

FY18 Software Artifacts

First Public SCALe Release (2.1.4)

Developed code to develop and test classifiers.
Code includes novel functionality:

- enables cross-taxonomy test suite classifiers (using precise mappings)
- enables "speculative mappings" for tools (e.g., GCC)

SCALe v2.1.3.0 released to collaborators
(December 2017-February 2018)

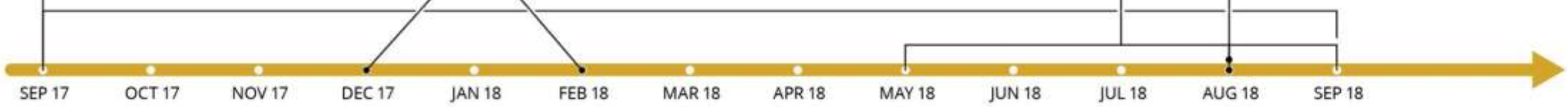
- New features for prioritization and classification
  - Fused alerts, CWEs, new determinations, etc. for collaborators to generate data

Started API definition (swagger) and code development

SCALe v2 GitHub release
(August 2018)

SCALe v3.0.0.0 released to collaborators

- New features for advanced prioritization schemes, user-uploaded fields, adjudication history, and classifier selection



FY18: Non-Code Publications

Publication Goal	Publications and Papers
Help developers and analysts provide feedback on our API and use new SCALe features.	• SEI special report: *Integration of Automated Static Analysis Alert Classification and Prioritization with Auditing Tools* (August 2018) • SEI blog post: *SCALe: A Tool for Managing Output from Static Code Analyzers* (September 2018)
Explain classifier development research methods and results.	• Paper: *Prioritizing Alerts from Multiple Static Analysis Tools, Using Classification Models*, SQUADE (ICSE workshop) • SEI blog post: *Test Suites as a Source of Training Data for Static Analysis Alert Classifiers* (April 2018) • SEI podcast (video): *Static Analysis Alert Classification with Test Suites* (September 2018)
Enable developers and analysts to better understand tool coverage for code flaws using our inter-taxonomy precise mapping method.	• CERT manifest for Juliet (created to test CWEs) to test CERT rule coverage with tens of thousands of tests (previously under 100) • Per-rule precise CWE mapping in two new CERT C Standard sections [1] [2]

Juliet Test Suite Classifiers: Initial Results (Hold-Out Data)

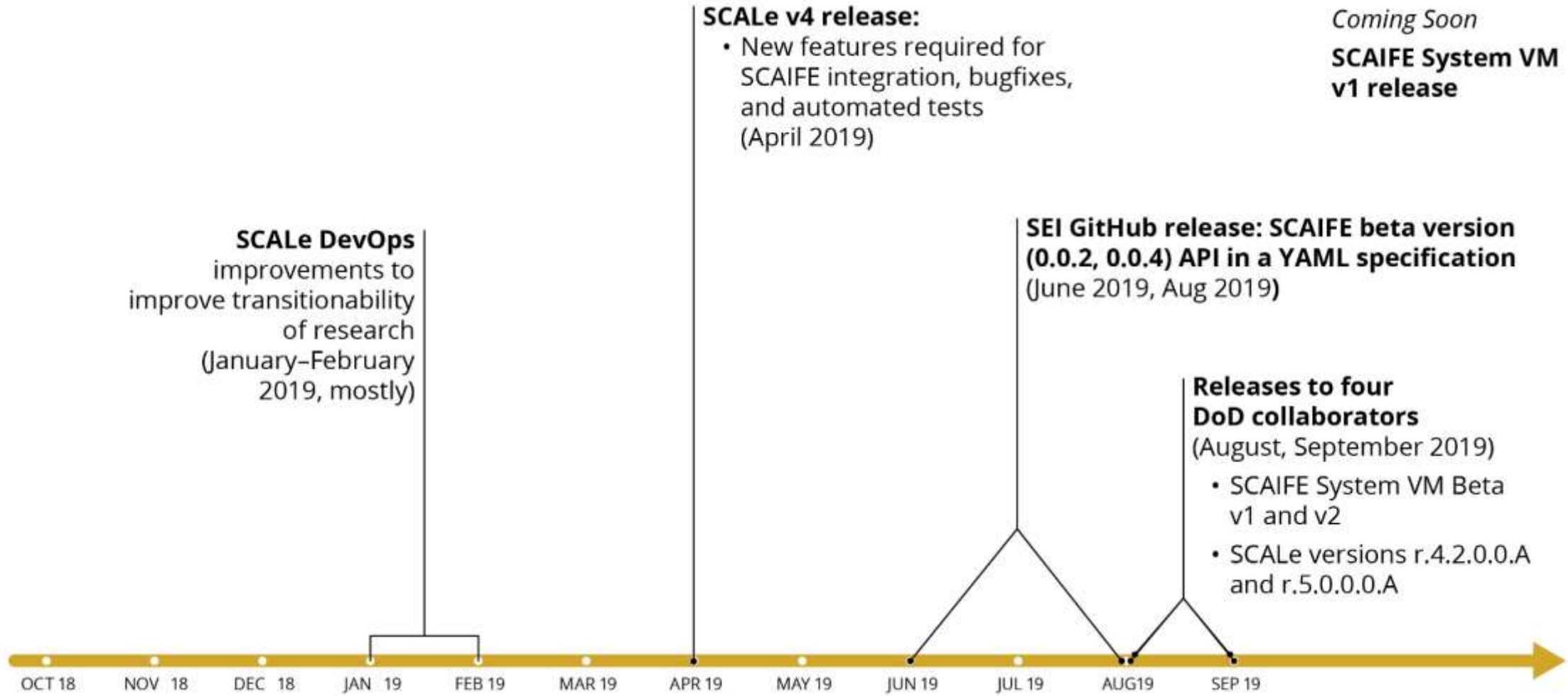
Classifier	Accuracy	Precision	Recall
rf	0.938	0.893	0.875
lightgbm	0.942	0.902	0.882
xgboost	0.932	0.941	0.798
lasso	0.925	0.886	0.831

	Total Population	Actual Condition: Condition true	Actual Condition: Condition false	
				Accuracy = $\frac{\Sigma \text{ True positive} + \Sigma \text{ True negative}}{\Sigma \text{ Total population}}$
Predicted Condition	Predicted condition true	True positive	False positive	Precision = $\frac{\Sigma \text{ True positive}}{\Sigma \text{ Predicted condition true}}$
	Predicted condition false	False negative	True negative	

True positive rate = recall = sensitivity = $\frac{\Sigma \text{ True positive}}{\Sigma \text{ (Condition true)}}$

False positive rate = $\frac{\Sigma \text{ False positive}}{\Sigma \text{ (Condition false)}}$

FY19 Releases: Software and YAML API Definitions



FY19: Select Non-Code Publications –1

Publications to Explain Research and Development Methods and Results

- SEI blog post: *An Application Programming Interface for Classifying and Prioritizing Static Analysis Alerts* by Lori Flynn, and Ebonie McNeil (July 2019)
- SEI whitepaper: *SCAIFE API Definition Beta Version 0.0.2 for Developers* by Lori Flynn and Ebonie McNeil (June 2019)
- SEI technical report: *Integration of Automated Static Analysis Alert Classification and Prioritization with Auditing Tools: Special Focus on SCALe* by Lori Flynn, Ebonie McNeil, David Svoboda, Derek Leung, Zach Kurtz, and Jiyeon Lee (May 2019)
- SEI blog post: *SCALe v3: Automated Classification and Advanced Prioritization of Static Analysis Alerts* by Lori Flynn and Ebonie McNeil (December 2018)
- Presentation: *Automating Static Analysis Alert Handling with Machine Learning: 2016-2018* (one-hour presentation at Raytheon's CyberSecurity Technical Interchange Meeting) by Lori Flynn (October 2018)

FY19: Select Non-Code Publications –2

Publications to Demonstrate New Features of SCALe and SCAIFE

- Manual: *How to Review & Test the Beta SCAIFE VM* by L. Flynn, E. McNeil, & A. Woods (v1 August 2019, v2 September 2019)
- SEI Cyber Minute by Ebonie McNeil (August 2019)
- SEI webinar: *How can I use new features in CERT's SCALe tool to improve how my team audits static analysis alerts?* (video and slides) by Lori Flynn (November 2018)
- SwACon paper: *Introduction to Source Code Analysis Laboratory (SCALe)* (one-hour presentation, including demo at Software Assurance Conference [SwACon]) by Lori Flynn (November 2018)

Coming Soon

- Paper submissions to conferences (e.g., ICSE 2020) on classifier results and architecture model development

Source Code Analysis Integrated Framework Environment (SCAIFE)

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Status of SCAIFE

SCAIFE Architecture Approach

For efficient development of a robust API to enable widespread classifier use, we need a system architecture that

- Integrates with existing static analysis tools and aggregators (including SCALe)
- Supports classification and adaptive heuristic functionality
- Demonstrates fast response time for average and worst-case scenarios
- Provides extensibility for future research in static analysis, classification, architecture, and SecDevOps

Swagger/OpenAPI Open-Source Development Toolset

- Quickly develops APIs following the OpenAPI standard
- Auto-generates code for servers and clients in many languages
- Test server and client controllers with Swagger UI
- Widely used (10,000 downloads/day)

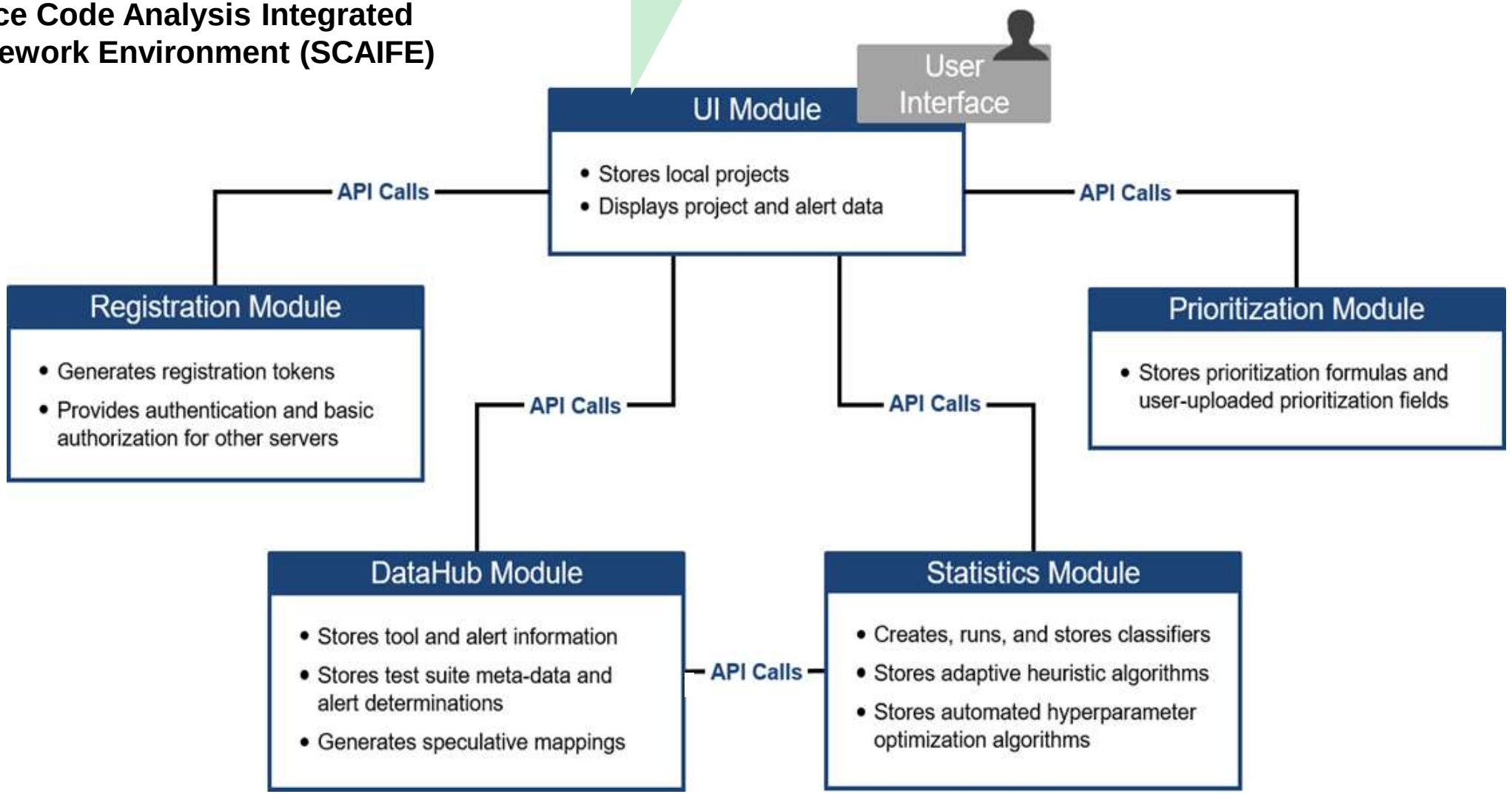
- Big O analysis was useful.
- Design decisions required balancing goals and analyzing tradeoffs.

SCAIFE Architecture

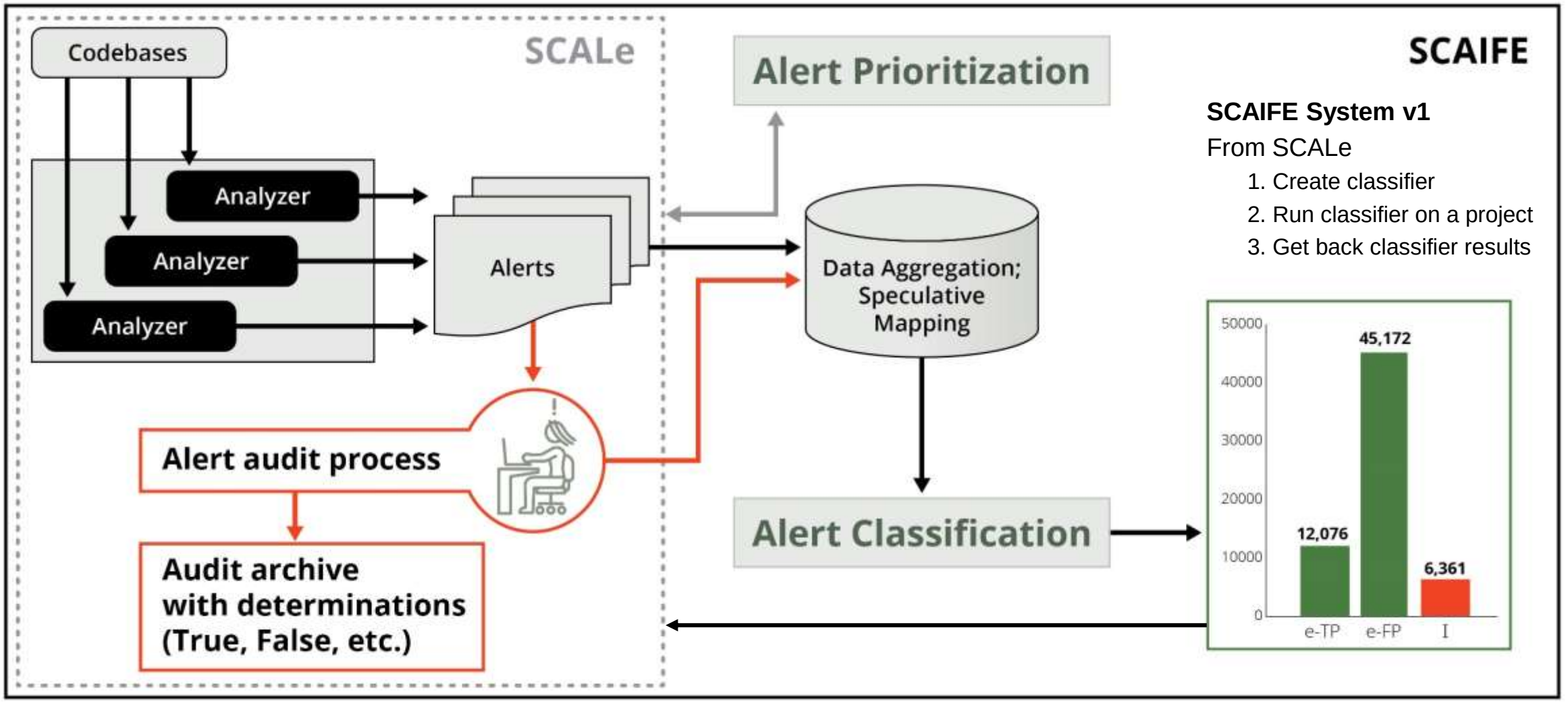
Any static analysis tool can instantiate APIs to become a UI Module. For example

- SEI SCALe
- DHS SWAMP
- CCDC C5ISR SwAT
- Other aggregator tools
- Single static analysis tools

Source Code Analysis Integrated Framework Environment (SCAIFE)



SCAIFE Alert Dataflow with SCALe Module



Status of SCAIFE v1

- **87% of the Statistics module functionality is complete.**
  - The Statistics module is coded with three classification types and three **adaptive heuristic (AH)** types.
- **91% of the Registration, DataHub, and Prioritization modules' functionality is complete.**
  - DataHub auto-adjudicates test suite data using SARD-style manifests.
  - Prioritization server stores prioritization schemes and restricts availability based on user organization ID, project ID, and scheme sharing type.
  - From UI (SCALe), users can register on SCAIFE, upload data to the SCAIFE DataHub, select a classifier and AH, and run classifier.
- **SCAIFE passes automated integration tests**, showing correct multi-server functionality.
- **SCAIFE fields were added/modified to improve future integration** as a result of reviewing multiple static analysis tool APIs.
- **AHs** require updates (e.g., new manual adjudications), resulting in new confidence values.
  - Various system dataflows are being considered to enable future AH use.

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Impacts Time Frame

AI Engineering-Related Topics

- Robust Systems: V&V, Tools & Process, Secure Coding
- Data, Devices, and Computing: Scalability, Performance and Evaluation

Project Impacts Time Frame

NEAR	MID	FAR
The public can review/use the API. DoD collaborators can further test SCAIFE to • provide data and feedback • integrate their tools using the API The FY20-21 research project incorporates continuous integration (CI) into architecture design.	More collaborators (DoD and non-DoD) to test SCAIFE with CI. Design improvements for transition include • classification precision • latencies • bandwidth/disk/memory use • business continuity • scalability	A wide variety of systems will do automated alert classification, using • SCAIFE System • SCAIFE API Goal: Provide better software security, or less time and cost for the same security (DoD and non-DoD).