Into the Rabbithole—

Evolved Web Application Security Testing

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> When I first came here, this was all swamp. Everyone said I was daft to build a castle on a swamp, but I built in all the same, just to show them.
> It sank into the swamp.
> So I built a second one. That sank into the swamp.
> So I built a third. That burned down, fell over, then sank into the swamp.
> But the fourth one stayed up. And that's what you're going to get, Lad, the strongest castle in all of England.

Monty Python & the Holy Grail (King of Swamp Castle)

Let's descend down the rabbit-hole

OR

Better testing through evolved automation

Automation: Love & Hate

Web App Sec has a
LOVE | HATE
relationship with automation

LOVE

✓ Automation speeds defect identification

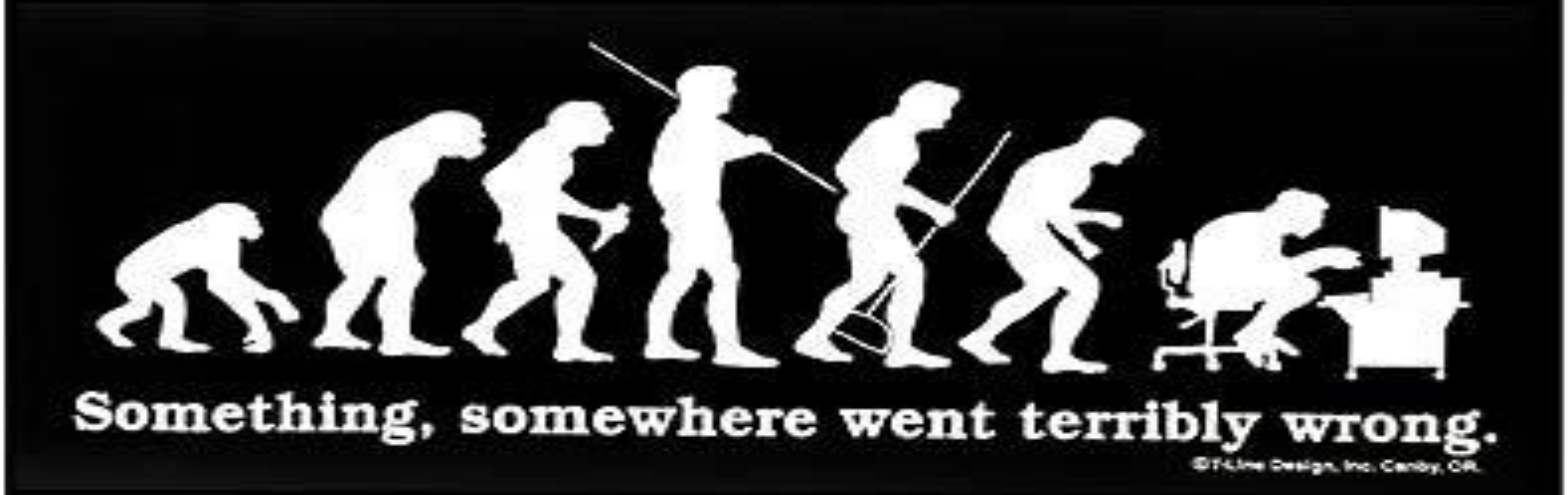
✓ Scanning is fast, quickly producing results

HATE

✓ Attack surface coverage unclear*

✓ Confuse automation's purpose

*More on the coverage problem shortly…


Something, somewhere went terribly wrong.
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Understanding Automation

Battle lines *(the classic arguments)*

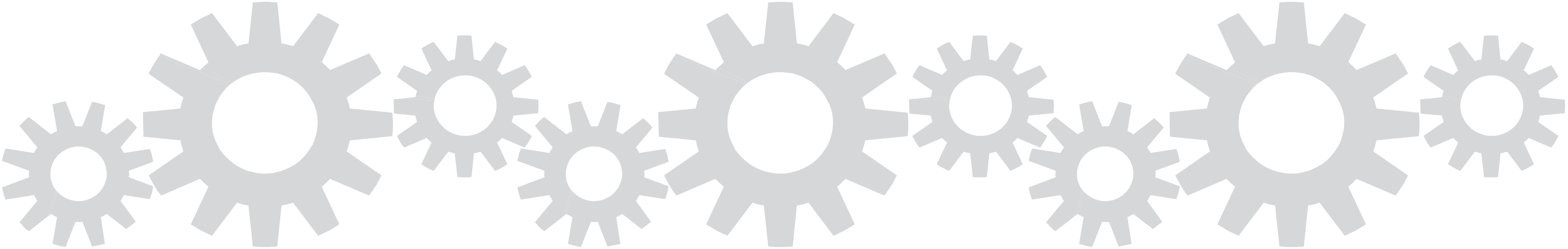
– Humans offer intelligence

– Automation offers limited scope

Benefits of automation

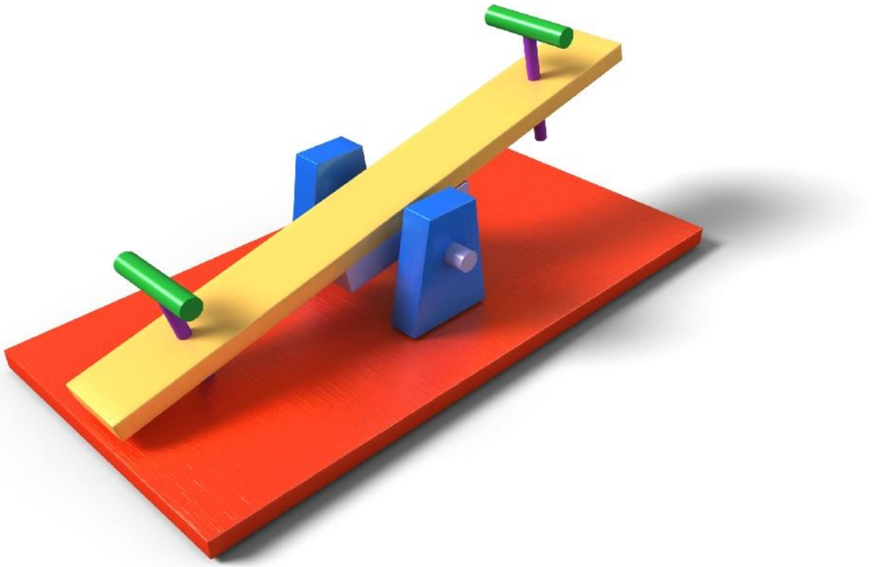
– Scalability: Analysis speed, coverage, processing

– Complexity: Applications are increasingly process-driven



So What?

We've reached
a tipping point



Why Did My Scanner Miss X?

Two **real** reasons

- X required a specific sequence, or **FLOW**
- X required **DATA** to get there

Data + Flow → no excuses

- IF tools have **data** + **logic**… the result is "smarter" automation
- No more "crawl n' hope"

“Radical” Testing Methodology

STOP **point n’ scan** web application security testing

ENLIGHTENED METHODOLOGY

- Application functional mapping w/data
- Layered automation-infused testing
- Concrete metrics & KPIs

Do what you do…

only smarter

Application Functional Mapping with Data

Defect vs. Vulnerability

How many of you have ever performed functional testing ?

Functional vs. Security Testing

QA TEAM	INFOSECURITY TEAM
Functions known	Functions unknown
Application understood	Application unknown
Rely on functional specifications	Rely on crawlers + experience + luck
Coverage known	Coverage unknown
Highlight key business logic	Highlight “found” functionality

Hard Lessons Learned

Security analysts, tools [today] aren't equipped to properly test **highly complex** applications…

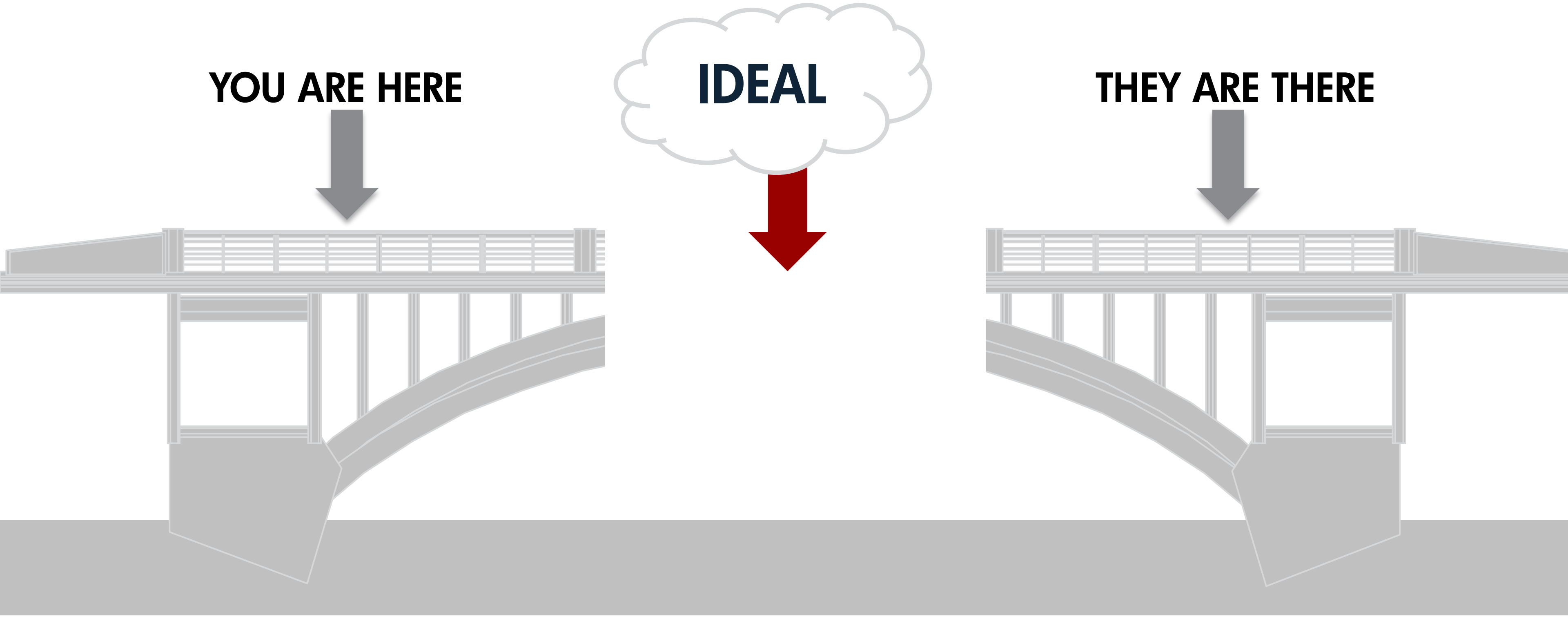
MISSING PIECES

- Understanding of application
- Functional mapping of application
- Application execution flow
- Valid test data

Bridging the Gaps

Is the kitchen-sink attack working?

Hint: It used to…not anymore



YOU ARE HERE

IDEAL

THEY ARE THERE

As All This Is Happening—
Technology Drives Forward…

Application State Is Changing

HTTP State

- Session/Cookie State
- Server State

Client State

- JavaScript State
- Silverlight/Flash State

Impossible to decouple HTTP from Client State

You can't just crawl/guess your way through a **modern, complex** application

Proposed Approach

Combine **functional** + **security** testing, compensating for technology

- Address **technology** complexities
  - Session states
  - Code-complexity
- Address **functional** complexities
  - Mapping application function as execution flows
  - Mapping data for driving execution flows

Incoming *New* Automation Technology!

Standards & Specifications

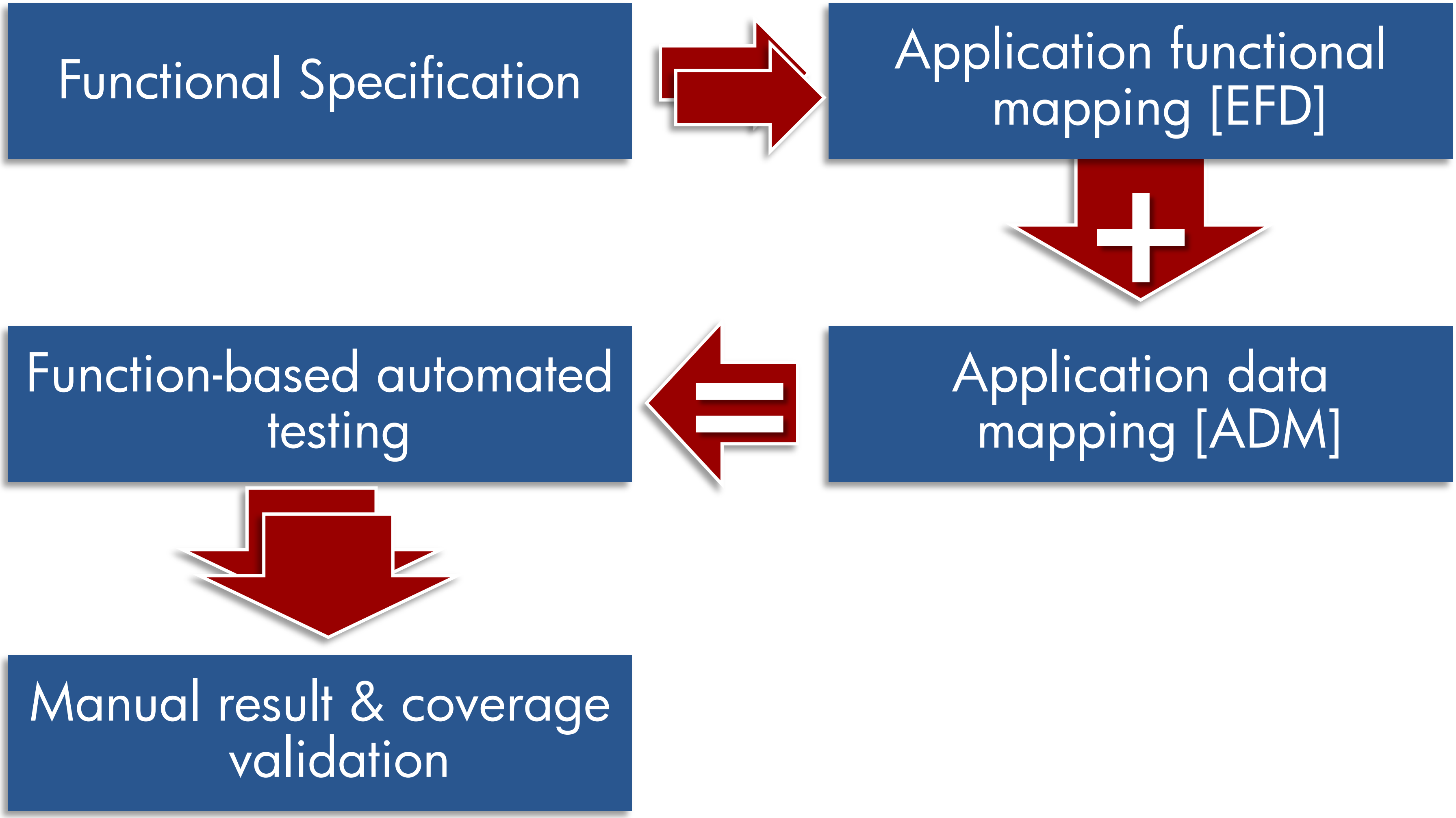
EFD

Execution Flow Diagram – Functional paths through the application logic

ADM

Application Data Mapping – Mapping data requirements against functional paths

Improving the Testing Process



Functional Specification

Application functional mapping [EFD]

+

Application data mapping [ADM]

=

Function-based automated testing

Manual result & coverage validation

Basics of the EFD & ADM

Basic EFD Concepts

Graph(s) of *flows through the application*

- Nodes represent application *states*
- Edges represent different *actions*
- Paths between nodes represent *state changes*
- A set of paths is a *flow*

Execution Flow Action Types

What is an **action**?

- **Something** that causes a change in **state**
- A human, server or browser-driven event

Three types of actions

- Direct
- Supplemental
- Indirect

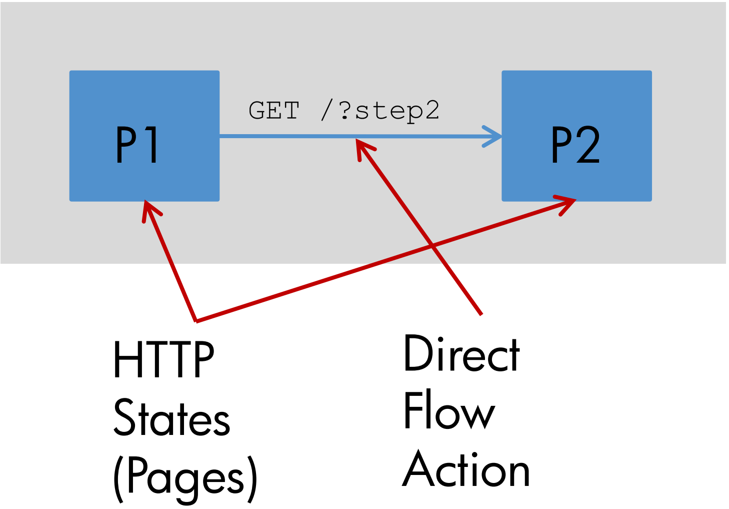
Direct Flow Actions

Actions which change the browser's document context

- Causes an entirely new browser page

Examples-

- Following hyperlink
- Click login button



Supplemental Flow Actions

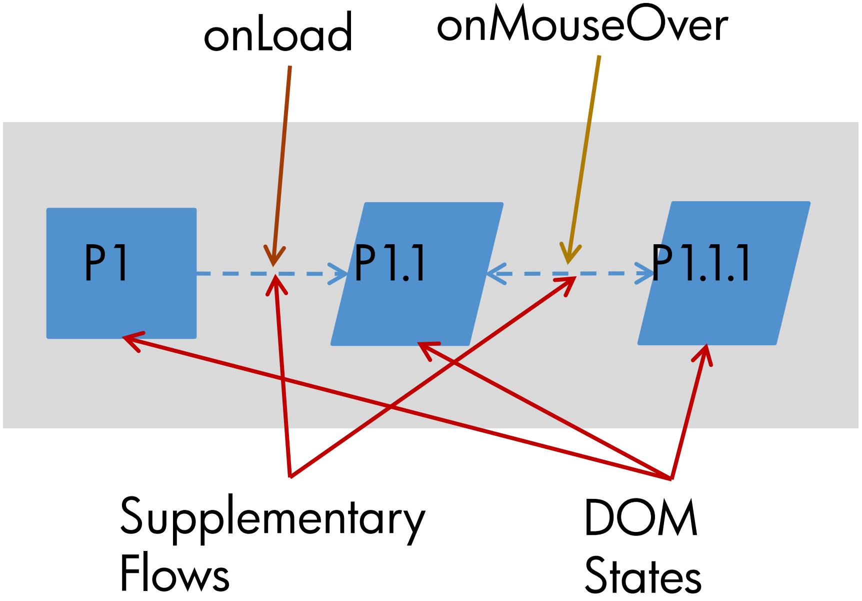
Actions that change the state of the current document

- Client-side action, maintaining browser page

Examples:

– JavaScript menu

– Flash client event



onLoad

onMouseOver

P1

P1.1

P1.1.1

Supplementary Flows

DOM States

Indirect Flow Actions

Actions **automatically triggered** by document context

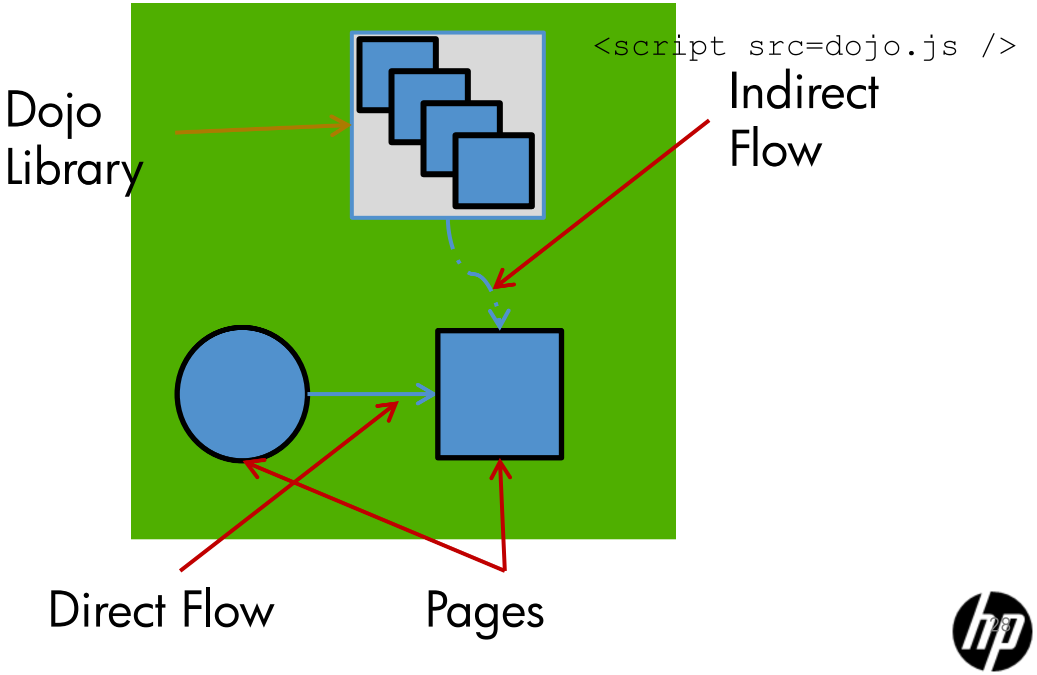
- Usually for supporting data, modifying document state

Examples:

– Site analytics (js)

– Stock ticker

– XMLHTTPrequest



Basic ADM Concepts

An Application Data Map [ADM] defines flows with the context of data

WHY?

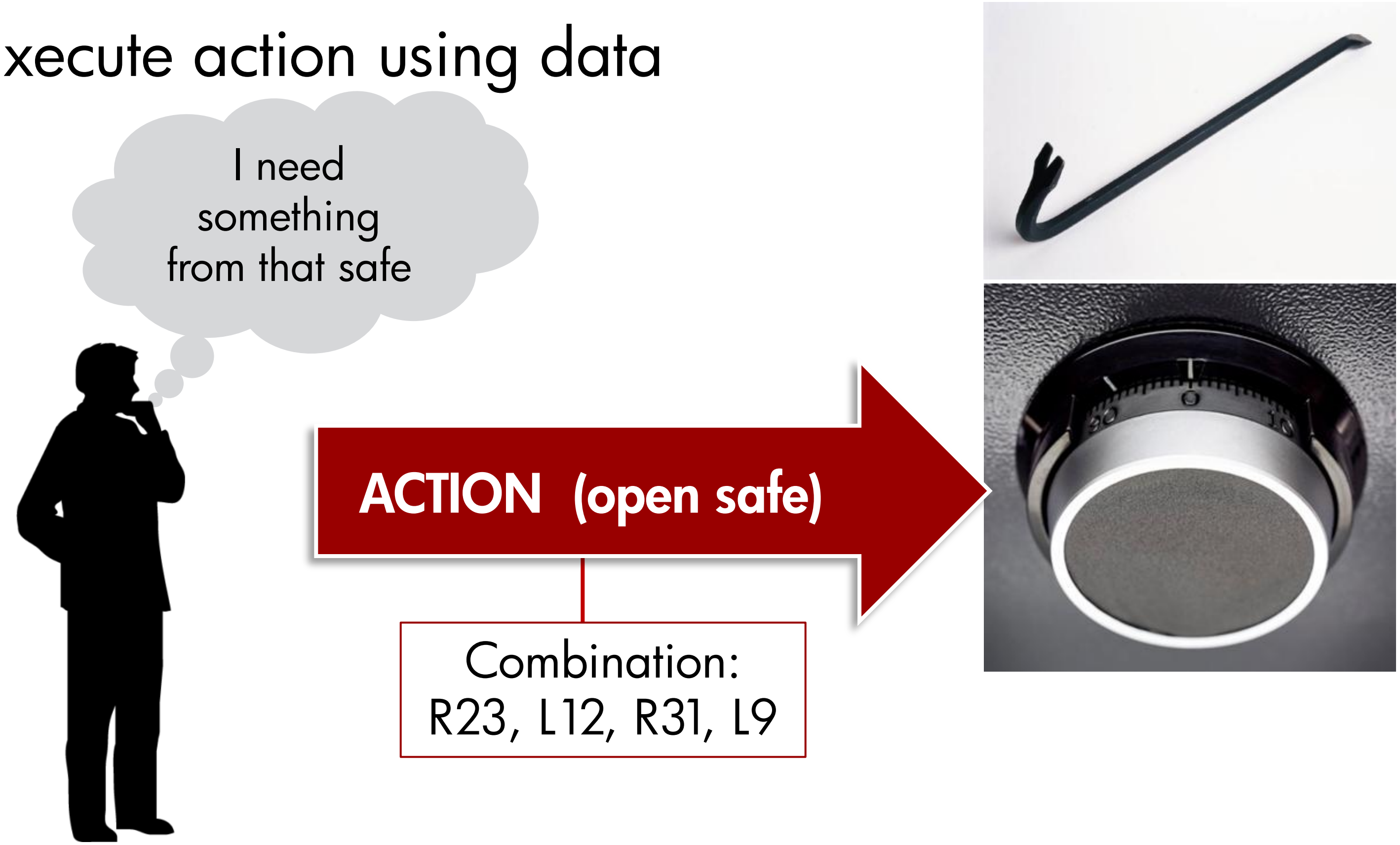
- Flows mean nothing without **DATA***
- Data should be **interchangeable**
  - Monitoring requests make this impossible – no context
- Data can be direct or indirect

**Where not specifically defined within an action (at the edge) the data values are assumed to be arbitrary*

ADM + EFD Visually

Retrieve something from a safe:

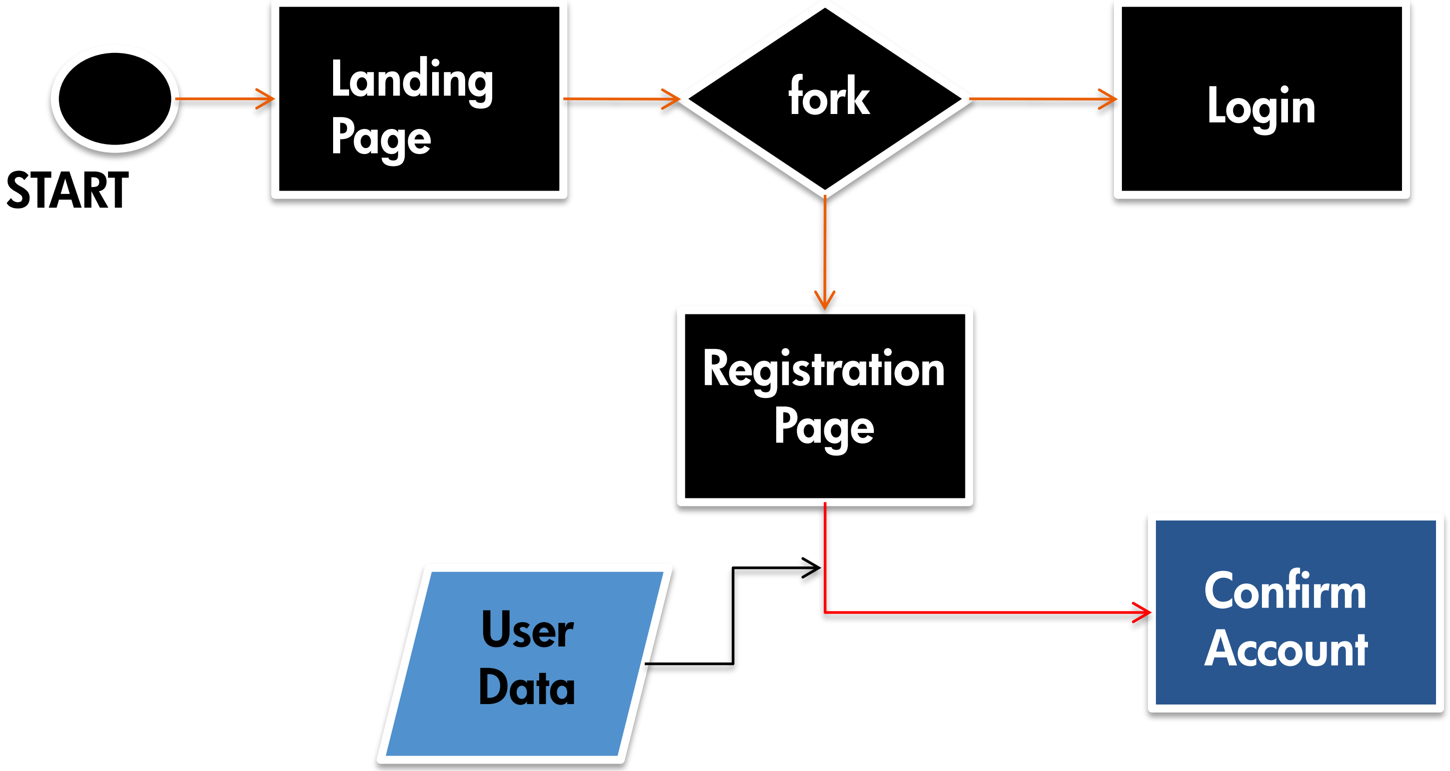
1. Map the action
2. Add data (context) necessary to execute
3. Execute action using data



I need something from that safe
ACTION (open safe)
Combination: R23, L12, R31, L9

ADM & EFD

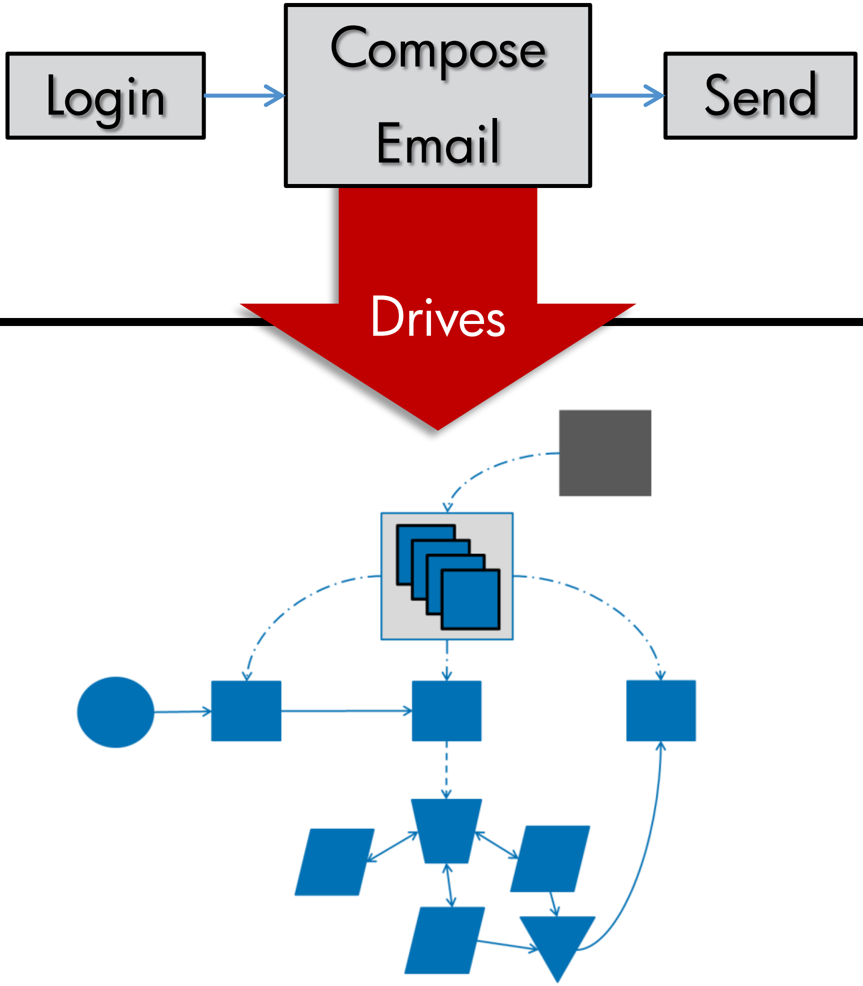
Another example: Web site registration



Putting It All Together (1)

Functional Level

Technical Level



Login

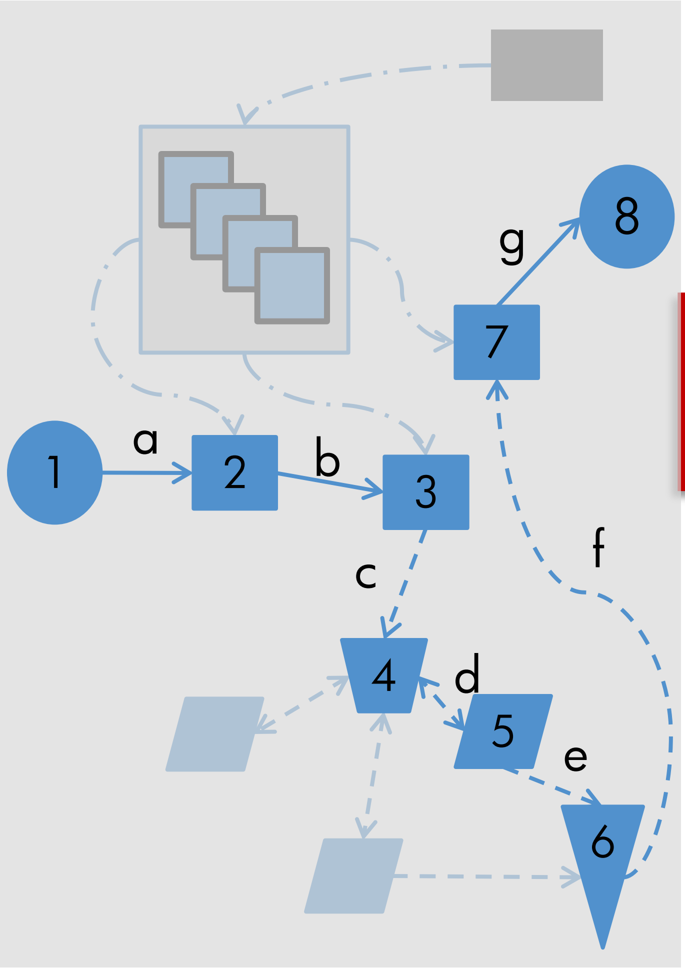
Compose Email

Send

Drives

Putting It All Together (2)

EFD



Drives

	JS DOM	HTTP
a		GET /
b		GET /?Login
c		GET /?Compose
d	onKeyPressed (160 times)	
e	DIV.onMouseOver	
f	LI.onChange	
g	FORM.submit()	GET /?Send

Putting It All Together (3)

	JS DOM	HTTP
a		GET /
b		GET /?Login
c		GET /?Compose
d	onKeyPressed (160 times)	
e	DIV.onMouseOver	
f	LI.onChange	
g	BTN.onClick	GET /?Send

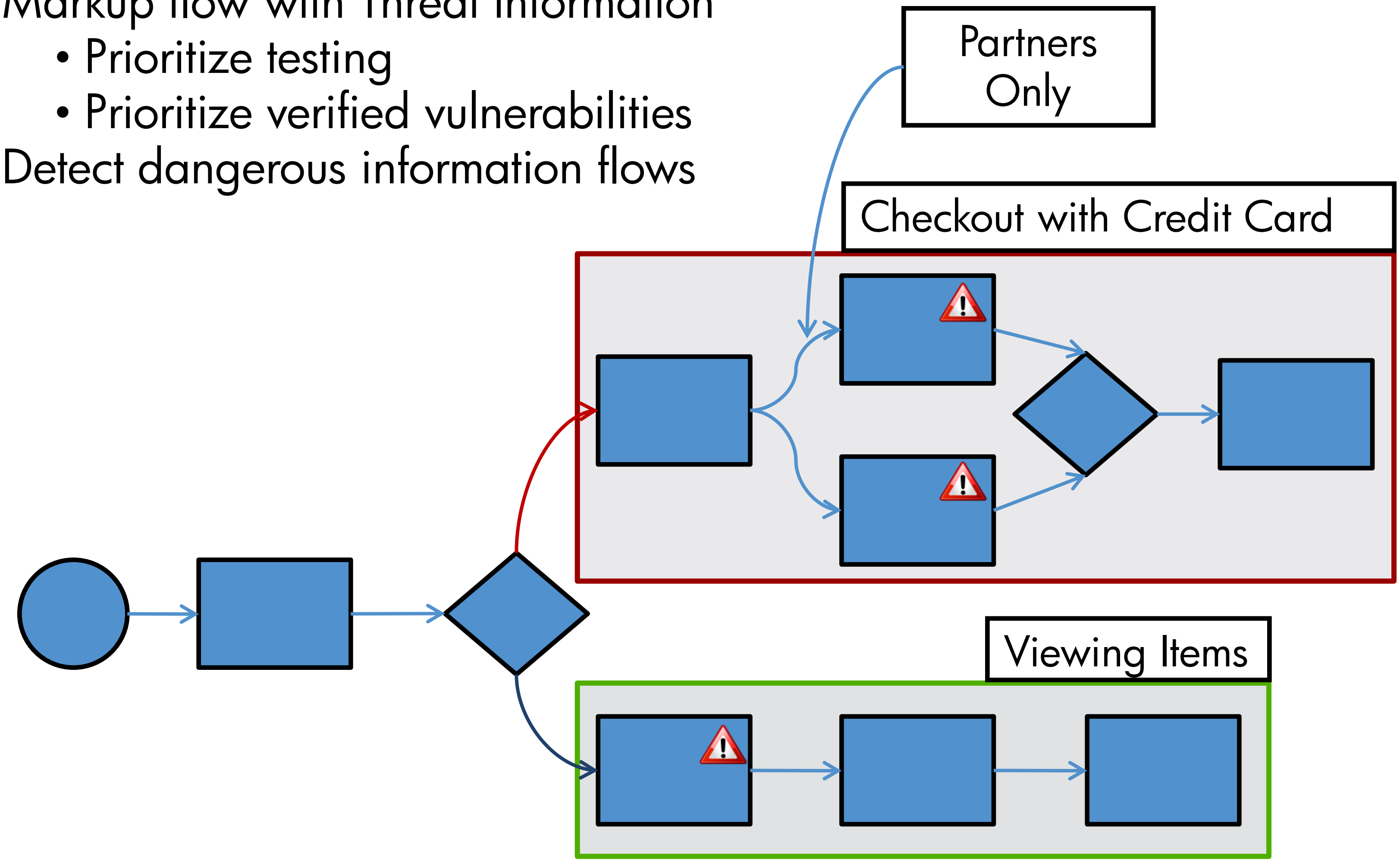
Drives

Data
N/A
User,Pass,Captcha
N/A
Email_Text
N/A
Send_To_Address
N/A

Applications of Execution Flow Diagrams

Flow Based Threat Analysis

- Markup flow with Threat Information
  - Prioritize testing
  - Prioritize verified vulnerabilities
- Detect dangerous information flows



Partners Only

Checkout with Credit Card

Viewing Items

Coverage Analysis

Flows defined by functional specification can be compared to security testing to determine gaps!

Q: “How much of the application was tested?”

A: “The scanner was able to test 8 of the 12 flows, we need to find out why/where it broke down”

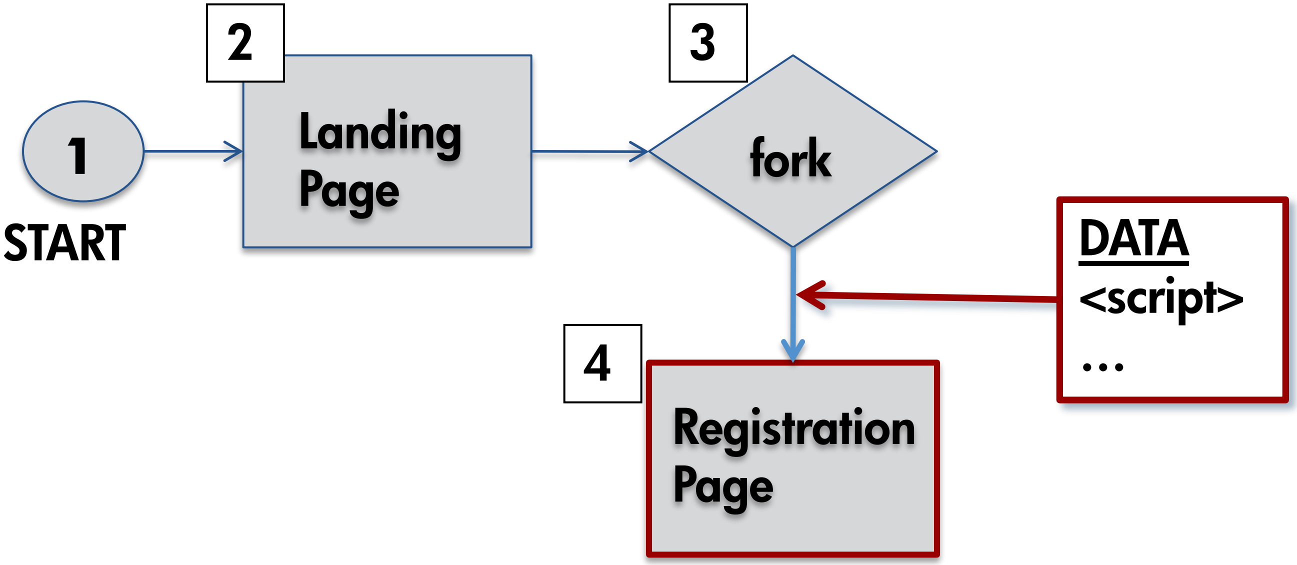
→ EFD can be referenced to determined where

→ ADM can be referenced to determine why

Flow-Based Reproduction

Demonstrate *exactly* how to reproduce a defect…

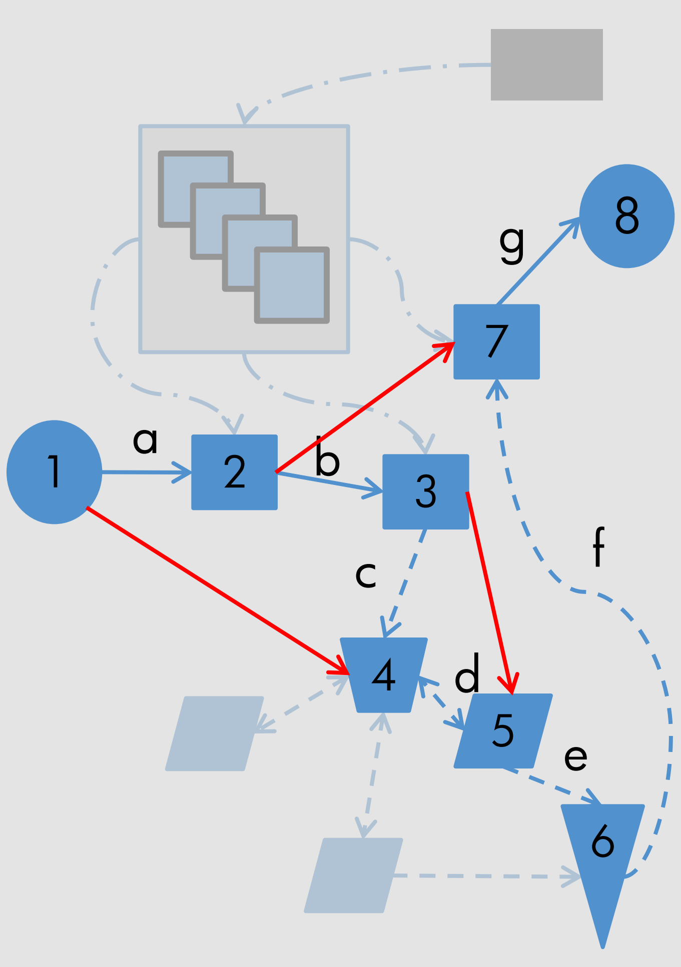
- Demonstrate where application failed
  - Steps executed
  - Data used



Dysfunctional Use of EFD

Vulnerabilities happen when using the application in an unintended way.

If we know the right logic paths…



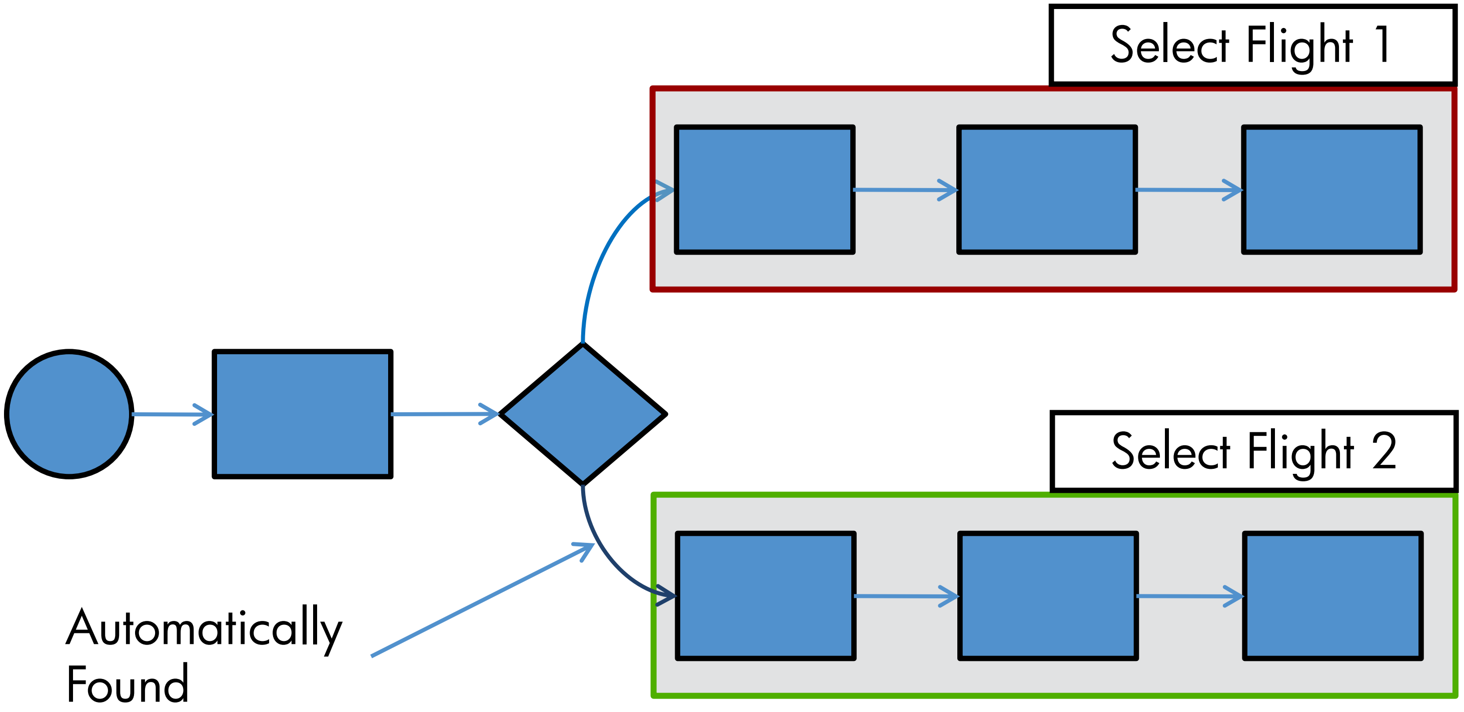
Next Generation Automation

Automation of execution flows

- Build maps from user-driven functional scripts
- Recording/Playback
  - Record HTTP requests
  - Record JavaScript events
  - Recording Client UI events
- Attacking
  - [Re]Play Flows
  - Auditing HTTP Parameters and HTML Inputs

Next: Automatic Exploration

- Similar paths can be easily enumerated
- JS Static Analysis to find other entry points to paths



For Next Time…

Layered automation-infused testing

Testing must be layered to fully understand the attack surface of the application, including multiple levels of authentication, business logic, data sets.

Concrete metrics & KPIs

In order to concretely prove functional coverage, application surface area coverage, defect remediation and ultimately risk reduction business-oriented metrics and KPIs must be gathered.

Get to it.

Insert cheesy cliché here…

…or you could just go do it.

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