

Building the Blockchain



Dan Appleman

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Prerequisites




Admins: Familiarity with declarative development on the Salesforce platform

Coders: Familiarity with software development on the Salesforce platform

In other words – this is not a beginner's developer course!



Traditional Build Process



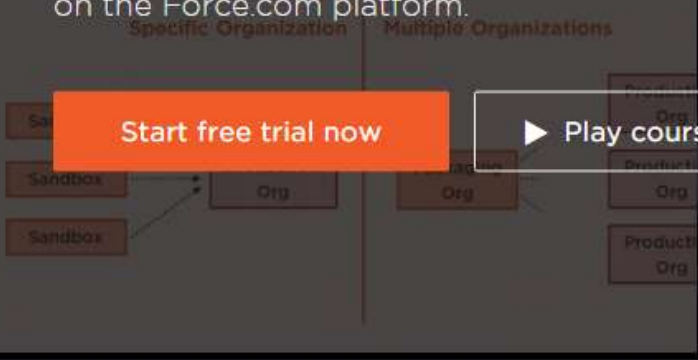
```
graph LR; A[Repository] --> B[Build System]; B --> C[Executable];
```

Force.com and Apex Fundamentals for Developers

★★★★★ By Dan Appleman

The opportunities for developers on the Force.com platform today are great, especially for experienced software developers. This course will help you quickly transfer your existing skills to building Apex applications on the Force.com platform.

Which is Your Target?



Start free trial now

▶ Play course overview

| | | |
|---|---------|---|
| Course Overview | 1m 35s | ^ |
| Course Overview | 1m 35s | |
| The Deceptive Nature of Apex | 8m 47s | ^ |
| 🔒 Welcome | 1m 56s | |
| 🔒 What Experts Know | 6m 50s | |
| Building Software on the Salesforce Platform | 1h 0m | ▾ |
| The Four Things Every Apex Developer Must Know to Avoid Failure | 1h 16m | ▾ |
| Surveying Apex Syntax: It May Look like Java or C#, but It's Not | 36m 2s | ▾ |
| Exploring the Salesforce Platform Class Library and Platform Features | 42m 45s | ▾ |

A Bit of Architecture



Requirements for Inserting Blocks



Insertion by authorized trusted sources



Stored as a record in a Salesforce custom object



All hash fields must be valid for new blocks



There Are Many Ways to Insert Records

| Insertion Method | Respects Security? |
|------------------|--------------------|
| User interface | |
| Declarative | |
| Data APIs | |
| Data tools | |
| Apex | |

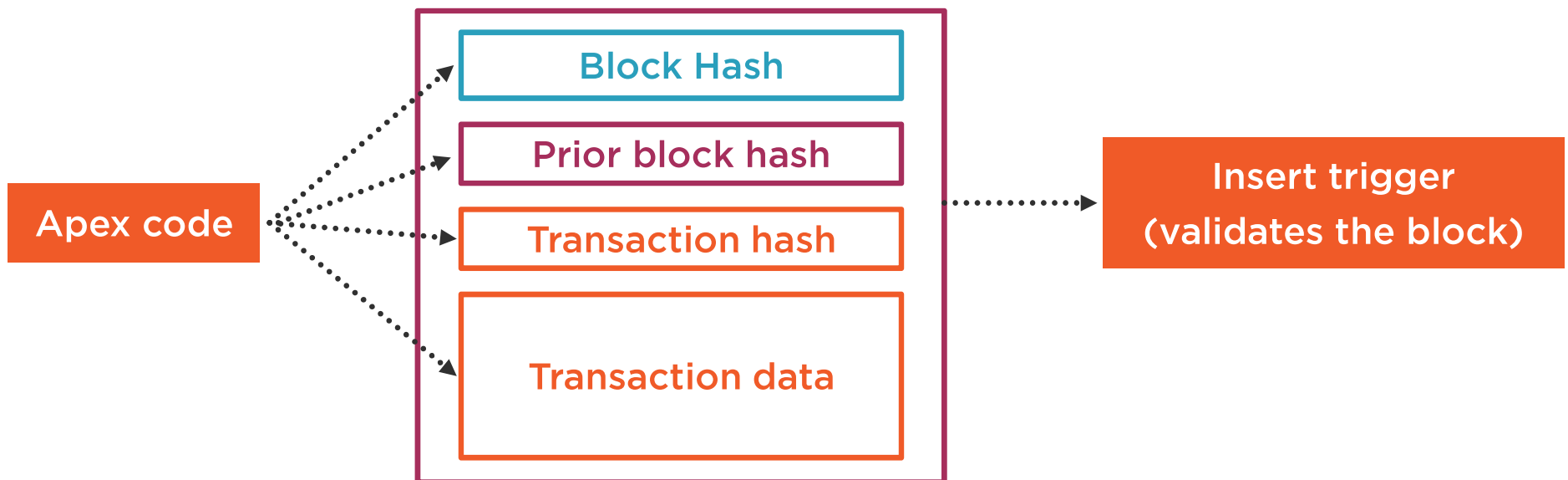


There Are Many Ways to Insert Records

| Insertion Method | Respects Security? |
|------------------|--------------------|
| User interface | Yes |
| Declarative | Yes |
| Data APIs | Yes |
| Data tools | Yes |
| Apex | Optional |



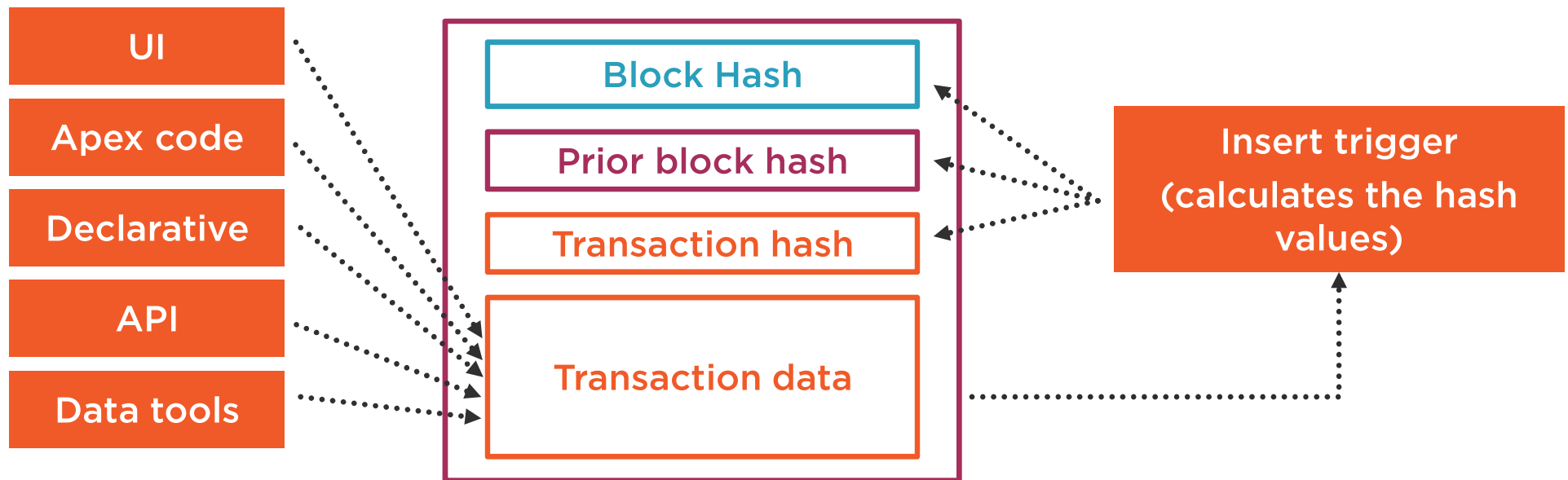
Option #1 – Add Blocks Using Code



Use security configuration and additional code to block updates and unauthorized insertion



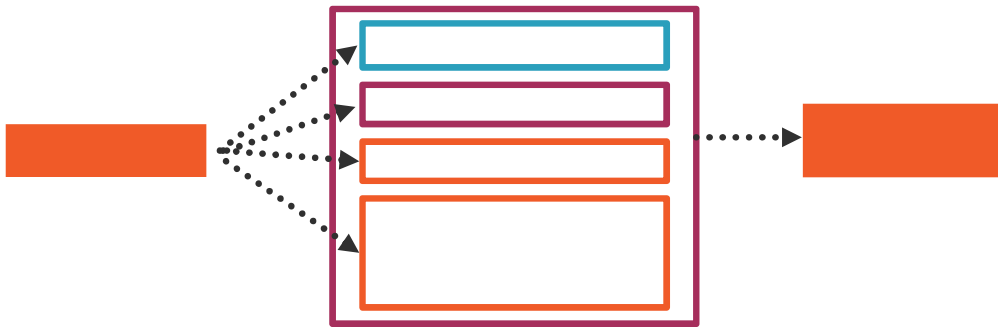
Option #2 - Calculate Blocks on Insert



Use security configuration and additional code to block updates and unauthorized insertion



Two Options



Option #1

Use code to calculate all block fields and set them directly.
Verify fields in database insert trigger



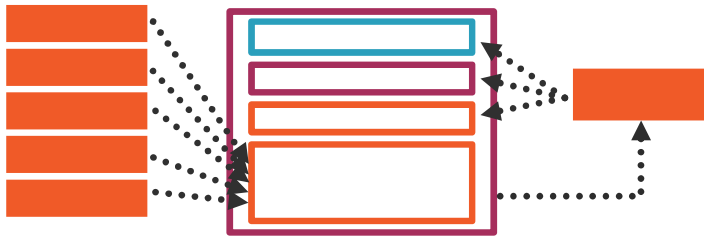
Option #2

Blocks can be inserted with transaction data only.
Calculate blockchain hash fields in database insert trigger



Our Choice

Option #2



However, both options would share certain design elements such as:

Handling concurrency issues

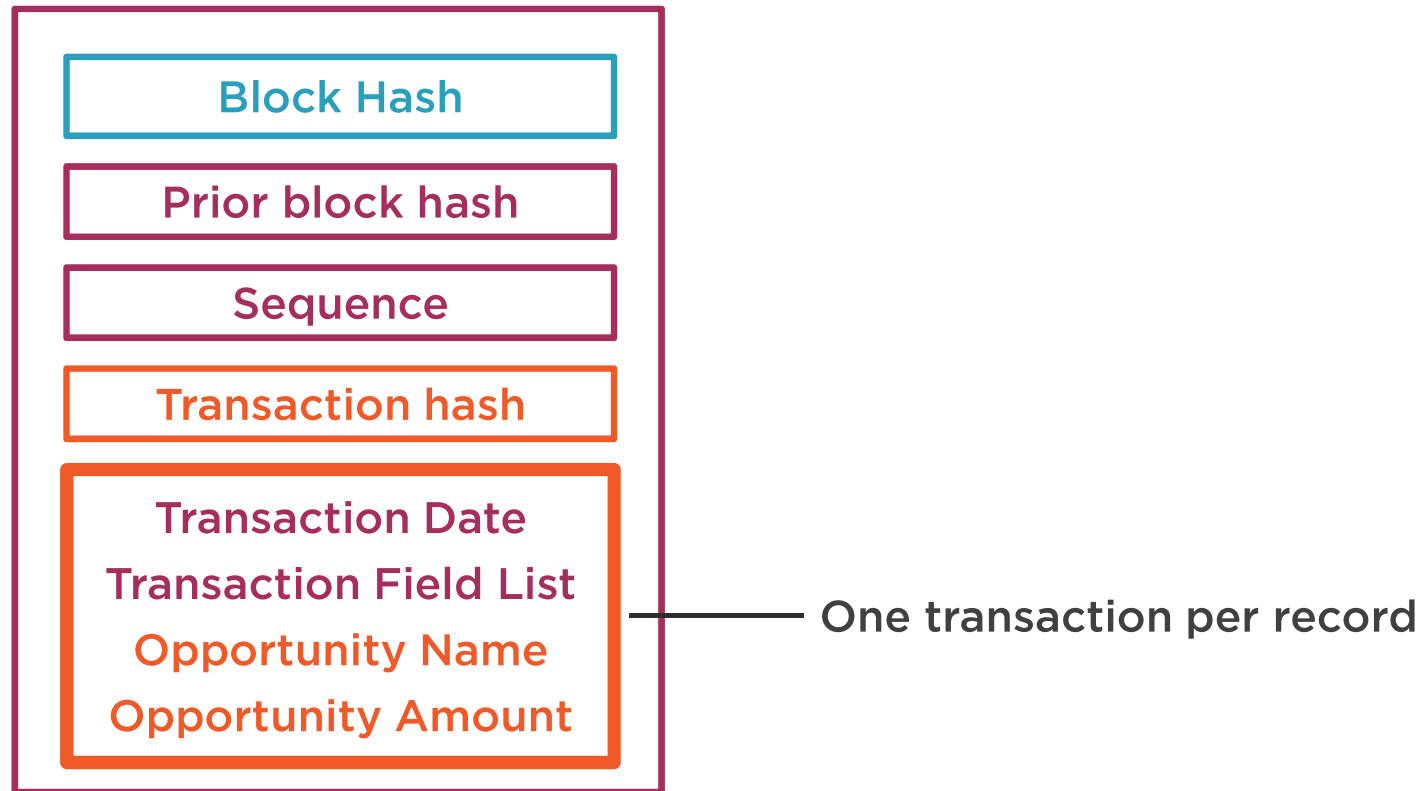
Using update triggers to secure the data



The Data Model



Our Data Model



The Ledger Entry custom object



Object Manager: Ledger

Secure | https://momentum-page-5021-dev-ed.lightning.force.com/one/one.app#/setup/object/0115B00000005IY9/edit?noId=ObjectManager&address=%2F0115B0000...

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Validation Rules

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Ledger Entry

Help for this Page

Custom Object Definition Edit

SaveSave & NewCancel

Custom Object Information

= Required Information

The singular and plural labels are used in tabs, page layouts, and reports.
Be careful when changing the name or label as it may affect existing integrations and merge templates.

Label

Ledger Entry

Example: Account

Plural Label

Ledger Entries

Example: Accounts

Starts with vowel sound

☐

The Object Name is used when referencing the object via the API.

Object Name

Ledger_Entry

Example: Account

Description

Entry in our prototype blockchain ledger

Context-Sensitive Help Setting

☒ Open the standard Salesforce.com Help & Training window

☐ Open a window using a Visualforce page

Content Name

—None—

Object Manager: Ledger

Secure | https://momentum-page-5021-dev-ed.lightning.force.com/one/one.app#/setup/object/01I5B0000005IY9/edit?nodeId=ObjectManager&address=%2F01I5B0000...

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Enter Record Name Label and Format

The Record Name appears in page layouts, key lists, related lists, lookups, and search results. For example, the Record Name for Account is "Account Name" and for Case it is "Case Number". Note that the Record Name field is always called "Name" when referenced via the API.

Record Name

Ledger Entry Name

Example: Account Name

Data Type

Auto Number

Display Format

{0000000000}

Example: A-{0000} [What Is This?](#)

Optional Features

☒ Allow Reports

☐ Allow Activities

☒ Track Field History

☐ Allow in Chatter Groups

Object Classification

When these settings are enabled, this object is classified as an Enterprise Application object. When these settings are disabled, this object is classified as a Light Application object. [Learn more.](#)

☒ Allow Sharing

☒ Allow Bulk API Access

☒ Allow Streaming API Access

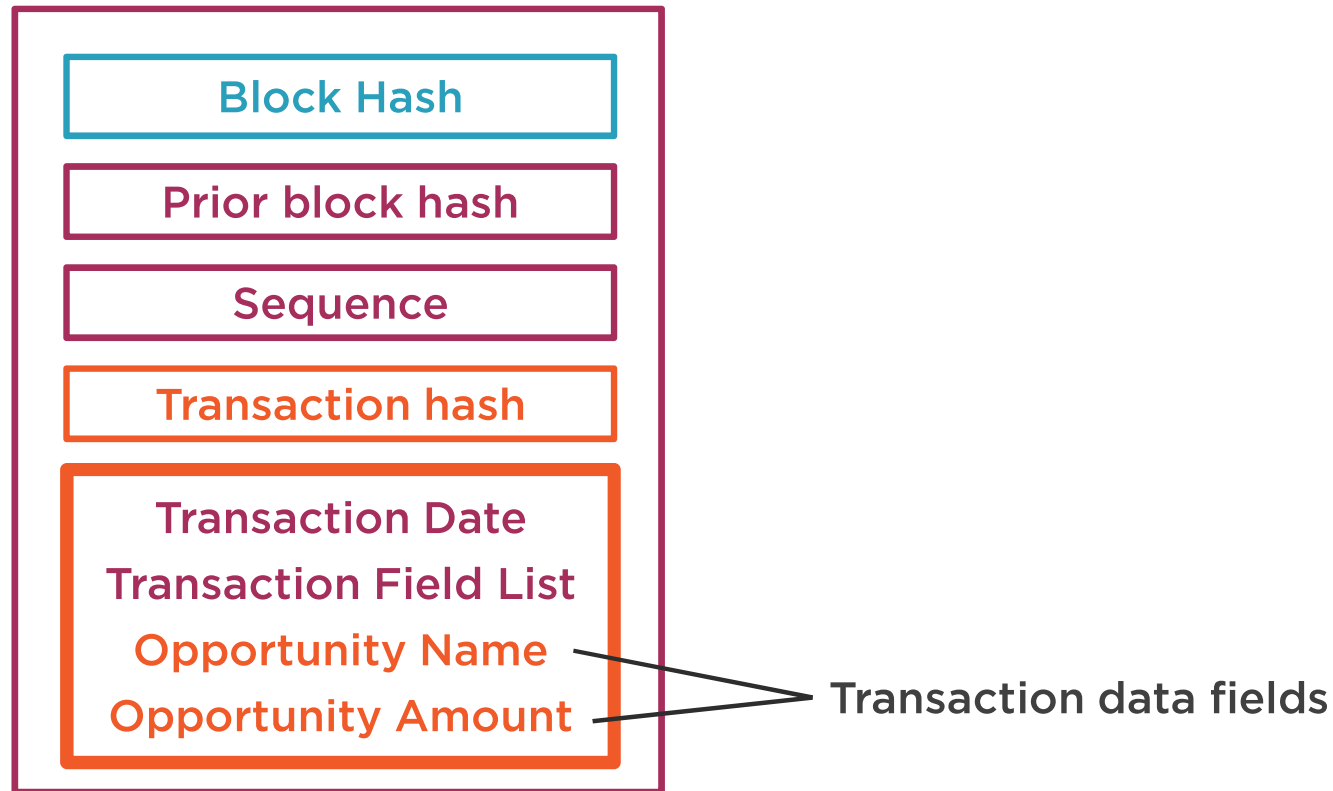
Deployment Status

☐ In Development

☒ Deployed

[What is this?](#)

Our Data Model



The Ledger Entry custom object



| | | | | | |
|---|---------------------------------|-----------------------|---|-------------------|---------|
| SETUP > OBJECT MANAGER | | Ledger Entry | | | |
| <div>Details</div> <div>Fields & Relationships</div> <div>Page Layouts</div> <div>Lightning Record Pages</div> <div>Buttons, Links, and Actions</div> <div>Compact Layouts</div> <div>Object Limits</div> <div>Record Types</div> <div>Related Lookup Filters</div> <div>Search Layouts</div> <div>Triggers</div> <div>Validation Rules</div> | Fields & Relationships | | Find in pageNewField DependenciesSet History Tracking | | |
| | 12 Items, Sorted by Field Label | | | | |
| | FIELD LABEL | FIELD NAME | DATA TYPE | CONTROLLING FIELD | INDEXED |
| | Block Hash | Block_Hash__c | Text(70) (External ID) (Unique Case Sensitive) | | ✓ |
| | Created By | CreatedById | Lookup(User) | | |
| | Last Modified By | LastModifiedById | Lookup(User) | | |
| | Ledger Entry Name | Name | Auto Number | | ✓ |
| | Opportunity Amount | Opportunity_Amount__c | Currency(18, 0) | | |
| | Opportunity Name | Opportunity_Name__c | Text(120) | | |
| | Owner | OwnerId | Lookup(User,Group) | | ✓ |
| | Prior Block Hash | Prior_Block_Hash__c | Text(70) (Unique Case Sensitive) | | ✓ |
| | Sequence | Sequence__c | Number(18, 0) (External ID) (Unique) | | ✓ |

Object Manager: Ledger Entry

Secure | https://momentum-page-5021-dev-ed.lightning.force.com/one/one.app#/setup/object/01I5B00000005IY9/FieldsAndRelationships/page?address=%2F00N5B000...

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Custom Field Definition Edit

Change Field Type

Save

Cancel

Field Information

Field Label

Opportunity Name

Data Type

Text

Field Name

Opportunity_Name

Description

Name of the opportunity

Help Text

i

General Options

Required

☐ Always require a value in this field in order to save a record

Unique

☐ Do not allow duplicate values

☒ Treat "ABC" and "abc" as duplicate values (case insensitive)

☐ Treat "ABC" and "abc" as different values (case sensitive)

External ID

☐ Set this field as the unique record identifier from an external system

Default Value

Show Formula Editor

Use formula syntax: Enclose text and picklist value API names in double quotes : ("the_text"), include numbers without quotes : (25), show percentages as decimals: (0.10), and express date calculations in the standard format: (Today() + 7)

Text Options

Length

120

Object Manager: Ledger Entry

Secure | https://momentum-page-5021-dev-ed.lightning.force.com/one/one.app#/setup/object/0115B00000005IY9/FieldsAndRelationships/page?address=%2F00N5B000...

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Validation Rules

Ledger Entry Custom Field

Opportunity Amount

Back to Ledger Entry

Validation Rules [0]

Custom Field Definition Detail

Edit

Set Field-Level Security

View Field Accessibility

Field Information

| | | | |
|-------------|------------------------------|-------------|------------------------------|
| Field Label | Opportunity Amount | Object Name | Ledger Entry |
| Field Name | Opportunity_Amount | Data Type | Currency |
| API Name | Opportunity_Amount__c | | |
| Description | Amount of the opportunity | | |
| Help Text | | | |
| Created By | User User, 1/28/2018 8:12 PM | Modified By | User User, 1/28/2018 8:19 PM |

General Options

Required

☐

Default Value

Currency Options

| | |
|----------------|----|
| Length | 16 |
| Decimal Places | 2 |

Validation Rules

New

Validation Rules Help

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Validation Rules

New

2 Items, Sorted by Rule Name

| RULE NAME | ERROR LOCATION | ERROR MESSAGE | ACTIVE | MODIFIED BY |
|--------------------------------------|----------------|---|--------|-------------------------------|
| Opportunity_Amount_must_be_specified | Top of Page | Opportunity amount must be specified in each ledger entry | ✓ | User User, 1/28/2018, 8:12 PM |
| Opportunity_name_must_be_specified | Top of Page | An opportunity name must be specified for each ledger entry | ✓ | User User, 1/28/2018, 8:12 PM |

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Ledger Entry Validation Rule

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Validation Rule Detail

EditClone

| | | | |
|-------------------------|---|----------------|------------------------------|
| Rule Name | Opportunity_Amount_must_be_specified | Active | ✓ |
| Error Condition Formula | ISBLANK(Opportunity_Amount__c) | | |
| Error Message | Opportunity amount must be specified in each ledger entry | Error Location | Top of Page |
| Description | Enforce opportunity amount | | |
| Created By | User User, 1/28/2018 8:12 PM | Modified By | User User, 1/28/2018 8:12 PM |

EditClone

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Ledger Entry Validation Rule

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Validation Rule Detail

| | | | |
|-------------------------|---|----------------|------------------------------|
| Rule Name | Opportunity_name_must_be_specified | Active | ✓ |
| Error Condition Formula | ISBLANK(Opportunity_Name__c) | | |
| Error Message | An opportunity name must be specified for each ledger entry | Error Location | Top of Page |
| Description | Enforce an opportunity name | | |
| Created By | User User, 1/28/2018 8:12 PM | Modified By | User User, 1/28/2018 8:12 PM |

Transaction Field Types



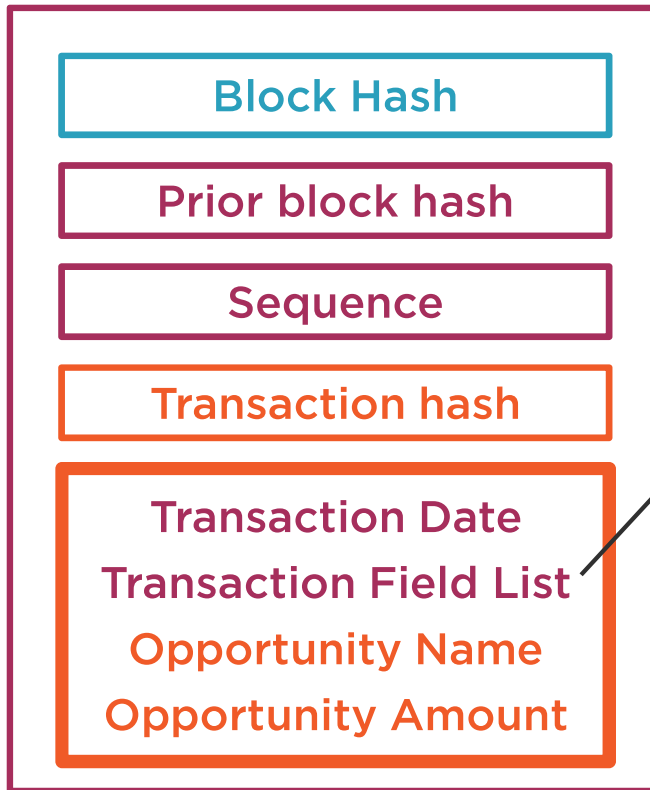
Avoid lookup (ID) fields – A deleted object can invalidate the whole chain, and exports and imports become impossible

Avoid formula fields – A changed value in a formula can invalidate the entire chain



You Can Add Fields Over Time

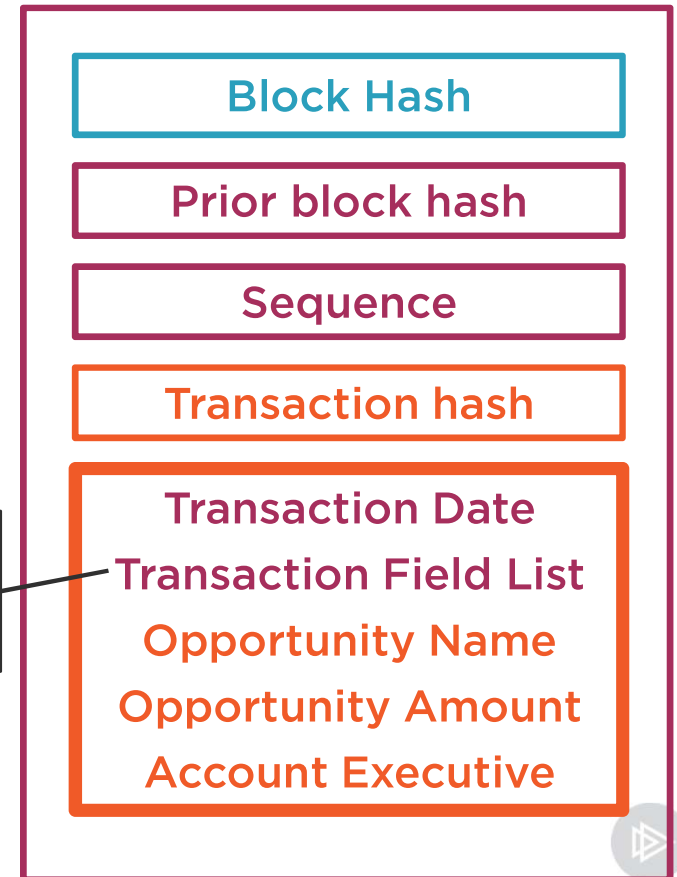
Ledger Entry V1



Opportunity_Name__c,
Opportunity_Amount__c

Opportunity_Name__c,
Opportunity_Amount__c
Account_Executive__c

Ledger Entry V2



Object Manager: Ledger Entry

Secure | https://momentum-page-5021-dev-ed.lightning.force.com/one/one.app#/setup/object/0115B00000005IY9/FieldsAndRelationships/page?address=%2F00N5B000...

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Transaction Field List

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Validation Rules [0]

Custom Field Definition Detail

Edit

Set Field-Level Security

View Field Accessibility

Field Information

| | | | |
|-------------|---|-------------|------------------------------|
| Field Label | Transaction Field List | Object Name | Ledger Entry |
| Field Name | Transaction_Field_List | Data Type | Long Text Area |
| API Name | Transaction_Field_List__c | | |
| Description | List of API names of fields included in the transaction. Fields must not be calculated and must not be relationship fields. | | |
| Help Text | | | |
| Created By | User User, 1/28/2018 8:12 PM | Modified By | User User, 1/28/2018 8:12 PM |

General Options

Default Value

Long Text Area Options

| | | | |
|-----------------|---|--------|--------|
| # Visible Lines | 3 | Length | 32,768 |
|-----------------|---|--------|--------|

Validation Rules

New

Validation Rules Help

No validation rules defined.

Object Manager: Ledger Entry

Secure | https://momentum-page-5021-dev-ed.lightning.force.com/one/one.app#/setup/object/01I5B00000005IY9/FieldsAndRelationships/page?address=%2F00N5B000...

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Validation Rules

Ledger Entry Custom Field

Transaction Date

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Validation Rules 101

Custom Field Definition Detail

EditSet Field-Level SecurityView Field Accessibility

Field Information

| | | | |
|-------------|------------------------------|-------------|------------------------------|
| Field Label | Transaction Date | Object Name | Ledger Entry |
| Field Name | Transaction_Date | Data Type | Date/Time |
| API Name | Transaction_Date__c | | |
| Description | Date of this transaction. | | |
| Help Text | | | |
| Created By | User User, 1/28/2018 8:12 PM | Modified By | User User, 1/28/2018 8:12 PM |

General Options

Required☐

Default Value

Validation Rules

New

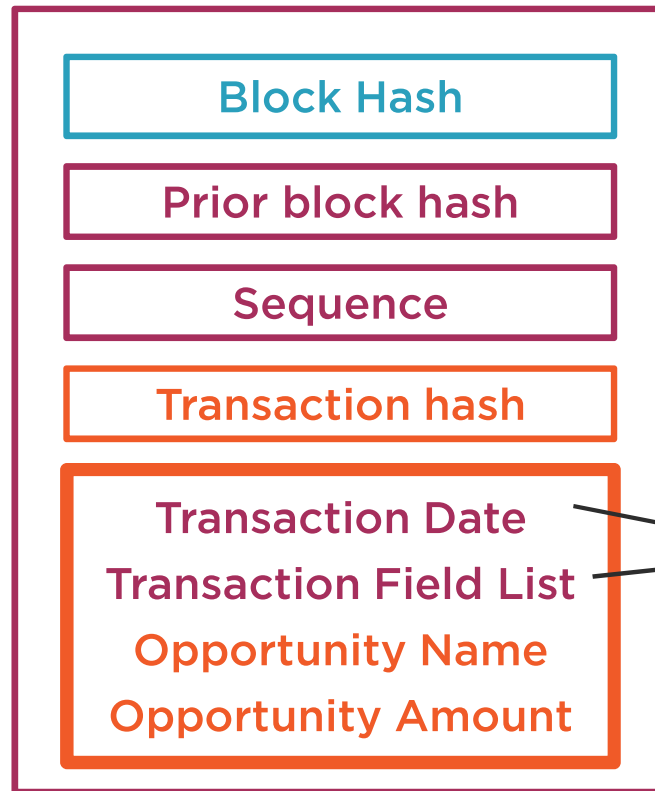
Validation Rules Help

No validation rules defined.

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Always show me more records per related list

Our Data Model

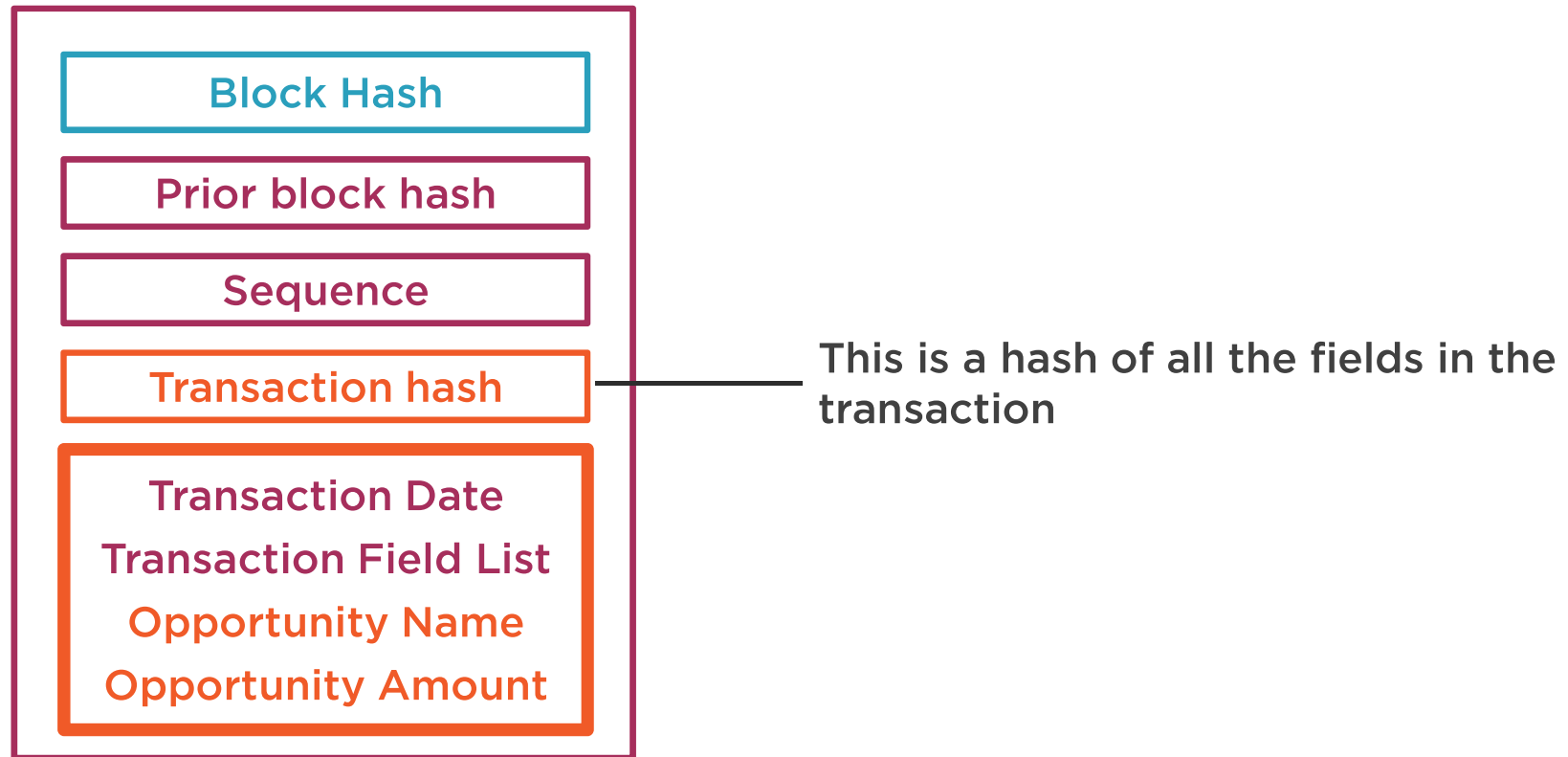


These are blockchain fields that we are hashing with the transaction. This will keep them private, and make the data more secure

The Ledger Entry custom object



Our Data Model



The Ledger Entry custom object



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Ledger Entry Custom Field

Transaction Hash

Back to Ledger Entry

Validation Rules [0]

Custom Field Definition Detail

EditSet Field-Level SecurityView Field Accessibility

Field Information

| | | | |
|-------------|--------------------------------|-------------|------------------------------|
| Field Label | Transaction Hash | Object Name | Ledger Entry |
| Field Name | Transaction_Hash | Data Type | Text |
| API Name | Transaction_Hash__c | | |
| Description | Hash of the transaction fields | | |
| Help Text | | | |
| Created By | User User, 1/28/2018 8:12 PM | Modified By | User User, 1/28/2018 8:12 PM |

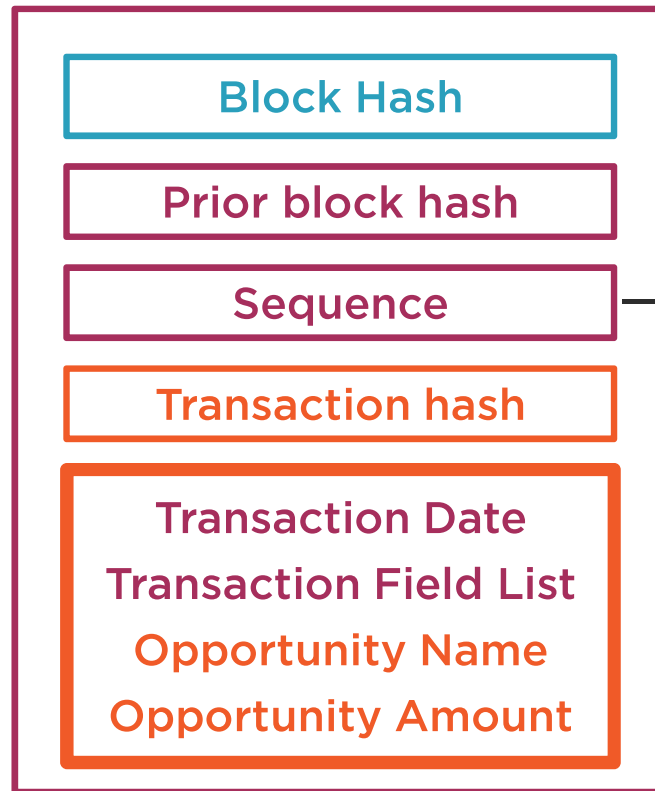
General Options

| | |
|----------------|--------------------------|
| Required | <input type="checkbox"/> |
| Unique | <input type="checkbox"/> |
| Case Sensitive | <input type="checkbox"/> |
| External ID | <input type="checkbox"/> |
| Default Value | |

Text Options

| | |
|--------|----|
| Length | 70 |
|--------|----|

Our Data Model



This is the position of the block in the blockchain. The first block is zero

The Ledger Entry custom object



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- Validation Rules

Ledger Entry Custom Field

Sequence

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Validation Rules [0]

Custom Field Definition Detail

EditSet Field-Level SecurityView Field Accessibility

Field Information

| | | | |
|-------------|---|-------------|------------------------------|
| Field Label | Sequence | Object Name | Ledger Entry |
| Field Name | Sequence | Data Type | Number |
| API Name | Sequence__c | | |
| Description | Sequence of this entry in the block chain | | |
| Help Text | | | |
| Created By | User User, 1/28/2018 8:12 PM | Modified By | User User, 1/28/2018 8:12 PM |

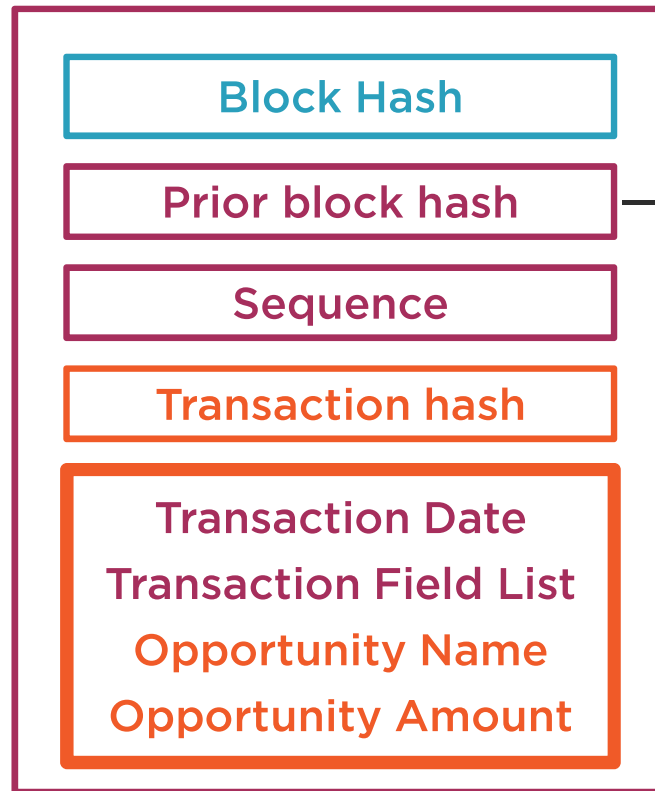
General Options

| | |
|---------------|-------------------------------------|
| Required | <input type="checkbox"/> |
| Unique | <input checked="" type="checkbox"/> |
| External ID | <input checked="" type="checkbox"/> |
| Default Value | |

Number Options

| | |
|----------------|----|
| Length | 18 |
| Decimal Places | 0 |

Our Data Model



This is the Block Hash of the previous block in the blockchain

The Ledger Entry custom object



Object Manager: Ledger Entry

Secure | https://momentum-page-5021-dev-ed.lightning.force.com/one/one.app#/setup/object/01I5B00000005IY9/FieldsAndRelationships/page?address=%2F00N5B000...

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Prior Block Hash

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Validation Rules [0]

Custom Field Definition Detail

Edit

Set Field-Level Security

View Field Accessibility

Field Information

| | | | |
|-------------|---|-------------|------------------------------|
| Field Label | Prior Block Hash | Object Name | Ledger Entry |
| Field Name | Prior_Block_Hash | Data Type | Text |
| API Name | Prior_Block_Hash__c | | |
| Description | Hash of the prior block (aka, block_hash__c of the prior block) | | |
| Help Text | | | |
| Created By | User User, 1/28/2018 8:12 PM | Modified By | User User, 1/28/2018 8:12 PM |

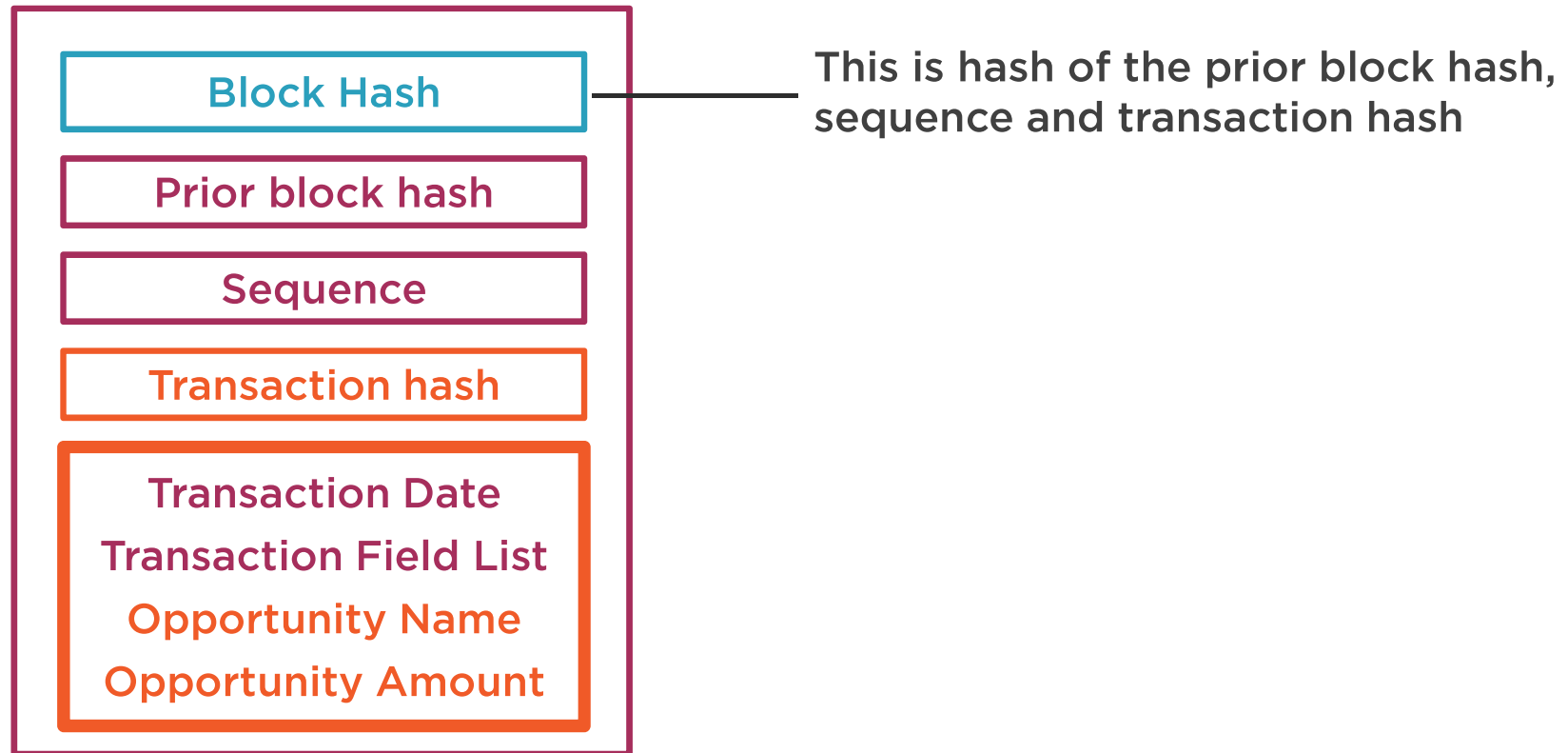
General Options

| | |
|----------------|-------------------------------------|
| Required | <input type="checkbox"/> |
| Unique | <input checked="" type="checkbox"/> |
| Case Sensitive | <input checked="" type="checkbox"/> |
| External ID | <input type="checkbox"/> |
| Default Value | |

Text Options

| | |
|--------|----|
| Length | 70 |
|--------|----|

Our Data Model



The Ledger Entry custom object



Object Manager: Ledger Entry

Secure | https://momentum-page-5021-dev-ed.lightning.force.com/one/one.app#/setup/object/01I5B00000005IY9/FieldsAndRelationships/page?address=%2F00N5B000...

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Validation Rules [0]

Custom Field Definition Detail

Edit

Set Field-Level Security

View Field Accessibility

Field Information

| | | | |
|-------------|--|-------------|------------------------------|
| Field Label | Block Hash | Object Name | Ledger Entry |
| Field Name | Block_Hash | Data Type | Text |
| API Name | Block_Hash__c | | |
| Description | The hash of the transaction hash and the previous block hash | | |
| Help Text | | | |
| Created By | User User, 1/28/2018 8:12 PM | Modified By | User User, 1/28/2018 8:12 PM |

General Options

| | |
|----------------|-------------------------------------|
| Required | <input type="checkbox"/> |
| Unique | <input checked="" type="checkbox"/> |
| Case Sensitive | <input checked="" type="checkbox"/> |
| External ID | <input checked="" type="checkbox"/> |
| Default Value | |

Text Options

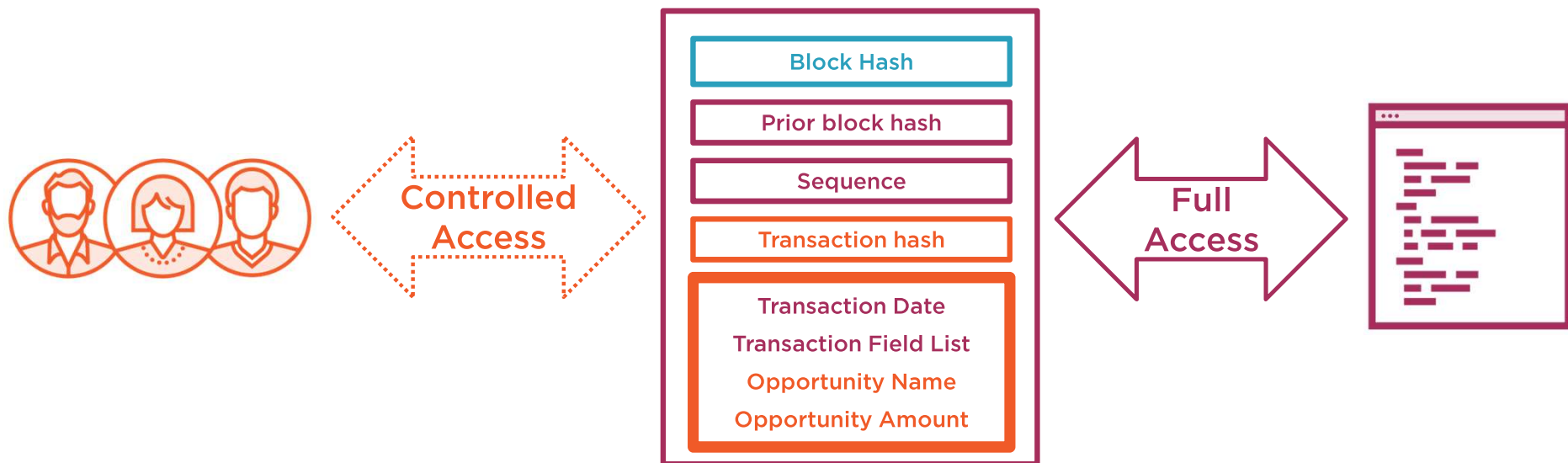
| | |
|--------|----|
| Length | 70 |
|--------|----|

Help for this Page

Creating and Validating Transactions



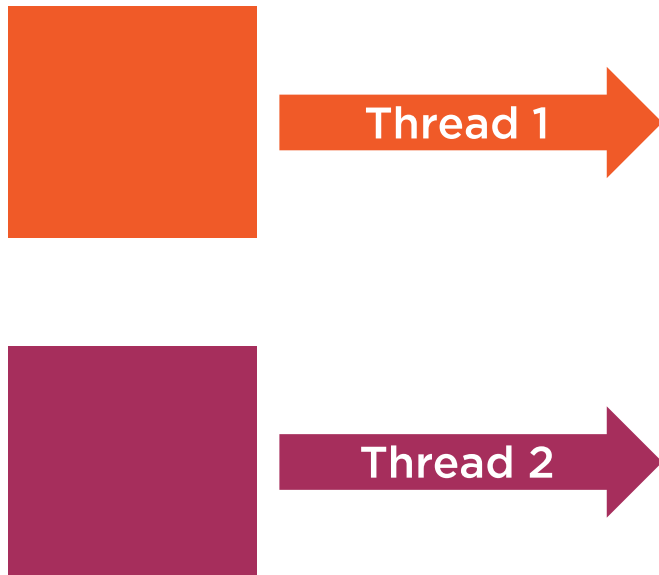
Choosing “Without Sharing”



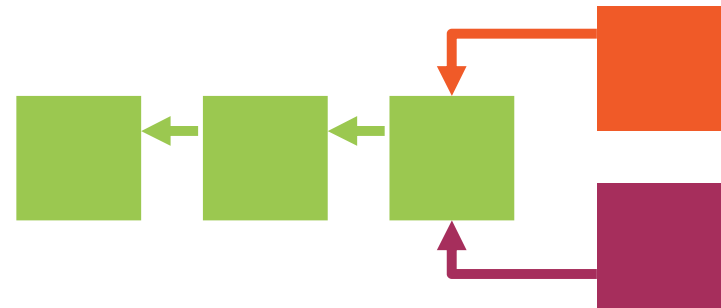
Adding Blocks to the Blockchain



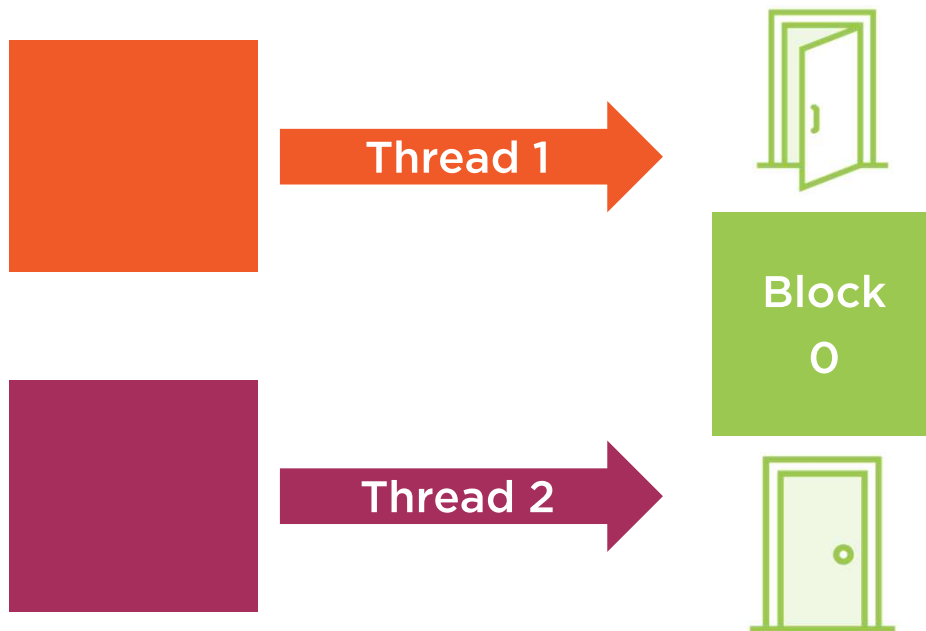
Multithreading Issues



Without a locking system, we might end up with this...



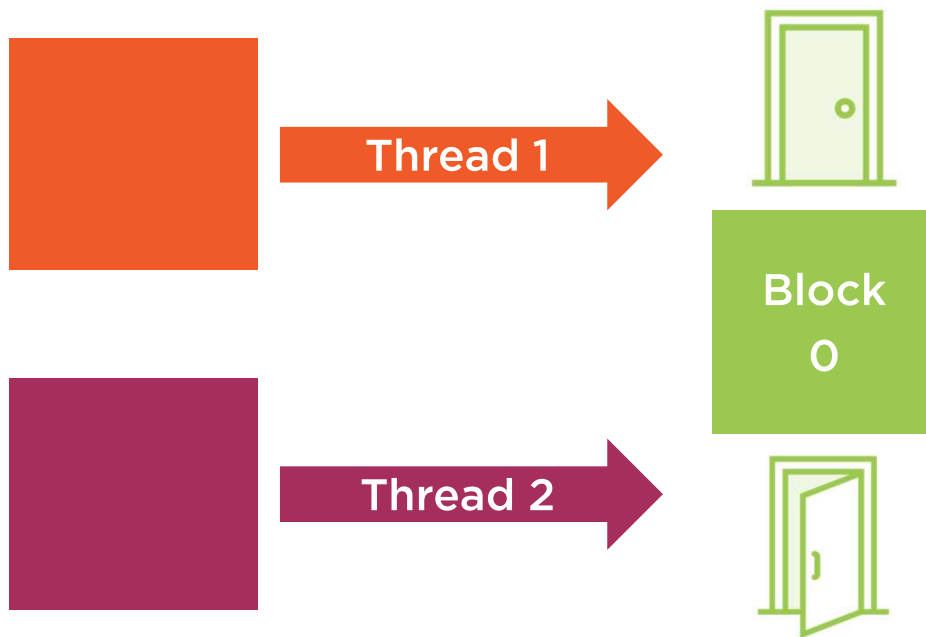
Multithreading Issues



The database lock provides access to one thread at a time



Multithreading Issues



The database lock provides access to one thread at a time



Validation Before Inserting Blocks

Option #1

**Validate the entire
blockchain**

**Not feasible in
Apex**

**Store requests for
processing after
validation**

**Possible, but
complex**

Option #2

**Trust that the
blockchain is valid**

**Trust routine
validation**



Validating the Blockchain



EXPLORER

OPEN EDITORS

OnInsertLedgerEntry.trig...

FORCECHAIN

- .sfdx
- .vscode
- config
- force-app
 - main
 - default
 - aura
 - classes
 - layouts
 - objects
 - profiles
 - tabs
 - triggers

OnInsertLedgerEntr..

OnInsertLedgerEntr..

- ≡ .forceignore
- ◆ .gitignore
- 📘 README.md
- 📄 sfdx-project.json

RUNNING TASKS

OnInsertLedgerEntry.trigger x

```
1 trigger OnInsertLedgerEntry on Ledger_Entry__c (before insert) {  
2  
3     LedgerSupport ls = new LedgerSupport(trigger.new);  
4     ls.processBlockInsertions();  
5  
6 }
```

EXPLORER

OPEN EDITORS

LedgeScheduleValidatio...

FORCECHAIN

.vscode

config

force-app

main

default

aura

classes

LedgeScheduleVal...

LedgeScheduleVal...

LedgeSupport.cls

LedgeSupport.cls...

LedgeTransaction....

LedgeTransaction....

LedgeValidation.cls

LedgeValidation.cl...

TestLedgeInsertion..

TestLedgeInsertion..

TestLedgeValidatio..

TestLedgeValidatio..

layouts

objects

profiles

tabs

triggers

RUNNING TASKS

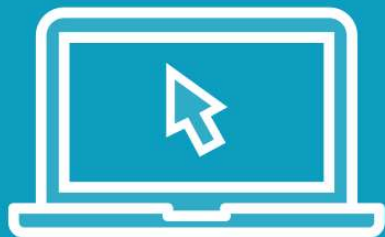
LedgeScheduleValidation.cls x

```
1 global without sharing class LedgeScheduleValidation implements Schedulable {
2     global void execute(SchedulableContext sc)
3     {
4         validateLedge();
5     }
6
7     global static void validateLedge()
8     {
9         LedgeValidation validationBatchClass = new LedgeValidation();
10        ID batchID = Database.executeBatch(validationBatchClass);
11    }
12 }
13
```

Securing the Blockchain



Demo



Using and securing the ledger



Don't forget to build a
delete trigger as well!



Combine Security Approaches

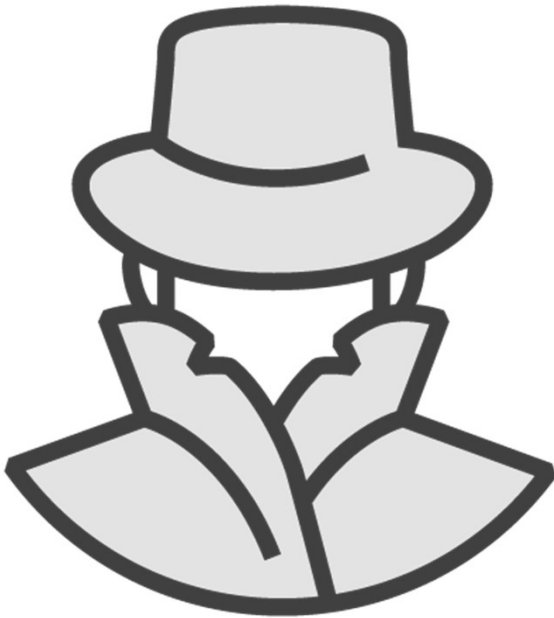
**Object and field
level security
(also page
layouts)**

**Sharing rules if
appropriate**

**Apex code
(triggers)**



Tampering with the Ledger



I have to do what?

Modify security configuration or gain admin access

Identify and disable triggers

Run away, because I won't be able to hide my trail



View Setup Audit Trail | S x

Ledger Validation | Sales x

Secure | https://momentum-page-5021-dev-ed.lightning.force.com/one/one.app#/setup/SecurityEvents/home?a:t=1517359930649

Search Setup

☆

+

?

⚙

🔔

👤

Setup

Home

Object Manager

audit

Security

View Setup Audit Trail

Didn't find what you were looking for? Search all of Setup instead.

SETUP

View Setup Audit Trail

View Setup Audit Trail

Help for this Page

The last 20 entries for your organization are listed below. You can [download](#) your organization's setup audit trail for the last six months (Excel .csv file).

View Setup Audit Trail

| Date | User | Source Namespace Prefix | Action | Section | Delegate User |
|--------------------------|------------------------------------|-------------------------|---|--------------|---------------|
| 1/30/2018 4:52:03 PM PST | test-qtq2eu0vt9oe@demo_company.net | | Changed Ledger Entry Trigger code: OnUpdateLedgerEntry | Apex Trigger | |
| 1/30/2018 4:37:38 PM PST | test-qtq2eu0vt9oe@demo_company.net | | Created Ledger Entry Trigger code: OnUpdateLedgerEntry | Apex Trigger | |
| 1/30/2018 4:35:40 PM PST | test-qtq2eu0vt9oe@demo_company.net | | Deleted Ledger Entry Trigger code: OnUpdateLedgerEntry | Apex Trigger | |
| 1/30/2018 4:30:13 PM PST | test-qtq2eu0vt9oe@demo_company.net | | Created Ledger Entry Trigger code: OnUpdateLedgerEntry | Apex Trigger | |
| 1/30/2018 4:18:49 PM PST | test-qtq2eu0vt9oe@demo_company.net | | Changed profile Cloned Standard User: Ledger Entry object permissions were changed from No Access to Read, Create, View All | Manage Users | |
| 1/30/2018 4:14:22 PM PST | test-qtq2eu0vt9oe@demo_company.net | | Created profile Cloned Standard User: Cloned from profile Standard User | Manage Users | |
| 1/30/2018 4:11:43 PM PST | test-qtq2eu0vt9oe@demo_company.net | | Changed tabs of custom app Sales | Custom Apps | |
| 1/30/2018 4:10:49 PM PST | test-qtq2eu0vt9oe@demo_company.net | | Changed profile Standard User: field-level security for Ledger Entry: Block Hash was changed from No Access to Read/Write | Manage Users | |
| 1/30/2018 4:00:53 PM PST | test-qtq2eu0vt9oe@demo_company.net | | Deleted Ledger Entry Trigger code: OnUpdateLedgerEntry | Apex Trigger | |
| | | | | Custom | |

It's Exactly What I Was Looking For!



Effective

Efficient

Simple

What's next?

