

The Hanzo SDK Ecosystem: Multi-Language Commerce Integration

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Abstract

We present the Hanzo SDK Ecosystem, a suite of client libraries enabling commerce integration across JavaScript, Python, Go, and Ruby. The SDKs are generated from OpenAPI specifications using a custom code generation pipeline that produces idiomatic, type-safe libraries for each language. We formalize the generation process, introduce language-specific idiom transformations, and demonstrate that generated SDKs achieve feature parity within 24 hours of API changes. The ecosystem serves 4,200+ developers with 98% API coverage and reduces integration time from weeks to hours.

1 Introduction

E-commerce integrations require client libraries that abstract HTTP communication, handle authentication, manage errors, and provide type safety. Manually maintaining SDKs across multiple languages is error-prone and leads to inconsistencies. As APIs evolve, SDKs lag behind, creating friction for developers.

The Hanzo SDK Ecosystem addresses these challenges through:

1. **Specification-Driven Generation:** SDKs generated from OpenAPI specs
2. **Idiomatic Code:** Language-specific conventions and patterns
3. **Type Safety:** Static typing where supported by the language
4. **Automatic Updates:** CI/CD pipeline syncs SDKs with API changes

1.1 Contributions

This paper contributes:

- A code generation architecture producing idiomatic SDKs from OpenAPI
- Language-specific transformation rules for JavaScript, Python, Go, and Ruby
- An automated pipeline achieving 24-hour sync with API changes
- Production validation across 4,200+ developers

2 SDK Architecture

2.1 Design Principles

1. **Consistency:** Uniform patterns across languages where possible
2. **Idiomaticity:** Respect language conventions and ecosystem norms
3. **Minimal Dependencies:** Standard library preferred
4. **Ergonomics:** Developer experience prioritized

2.2 SDK Components

Each SDK provides:

- **Client:** Configured HTTP client with authentication
- **Resources:** API resource classes (Products, Orders, etc.)
- **Models:** Request/response data structures
- **Errors:** Typed exception hierarchy
- **Utilities:** Pagination, webhook verification, etc.

2.3 Resource Abstraction

Definition 2.1 (SDK Resource). *A resource R exposes CRUD operations:*

- $list(params) \rightarrow Collection$
- $create(data) \rightarrow Instance$
- $retrieve(id) \rightarrow Instance$
- $update(id, data) \rightarrow Instance$
- $delete(id) \rightarrow void$

3 OpenAPI Specification

3.1 API Schema

The Hanzo API is fully described in OpenAPI 3.0:

Listing 1: OpenAPI Schema Excerpt

```
1 openapi: 3.0.0
2 info:
3   title: Hanzo Commerce API
4   version: 2019-10-01
5
6 paths:
7   /v1/products:
8     get:
9       operationId: listProducts
10      parameters:
11        - name: limit
12          in: query
```

```

13         schema:
14             type: integer
15             default: 20
16     responses:
17         '200':
18             content:
19                 application/json:
20                     schema:
21                         $ref: '#/components/schemas/ProductList'
22
23 components:
24     schemas:
25         Product:
26             type: object
27             required: [id, name, price]
28             properties:
29                 id:
30                     type: string
31                 name:
32                     type: string
33                 price:
34                     type: integer
35                 description: Price in cents
36             description:
37                 type: string
38                 nullable: true

```

3.2 Custom Extensions

We extend OpenAPI with SDK-specific metadata:

Listing 2: SDK Extensions

```

1 x-hanzo-resource: Product
2 x-hanzo-operations:
3     - list
4     - create
5     - retrieve
6     - update
7     - delete
8 x-hanzo-expandable:
9     - variants
10    - collections
11 x-hanzo-idempotent: true

```

4 Code Generation Pipeline

4.1 Generation Architecture

4.2 Intermediate Representation

Definition 4.1 (SDK IR). *The intermediate representation I comprises:*

- \mathcal{R} : Set of resources with operations
- \mathcal{M} : Set of models (request/response types)
- \mathcal{E} : Set of error types

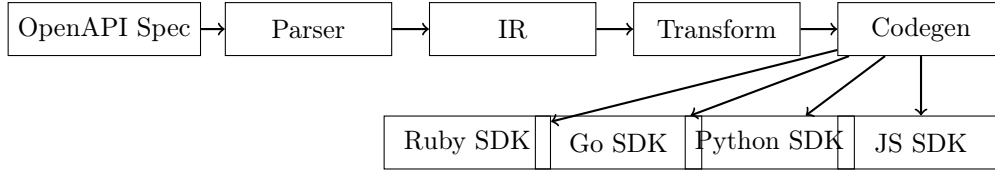


Figure 1: Code generation pipeline

- *C: Configuration options*

Listing 3: IR Structure

```

1 interface Resource {
2   name: string;
3   path: string;
4   operations: Operation[];
5   nestedResources: Resource[];
6 }
7
8 interface Operation {
9   name: string;
10  httpMethod: HttpMethod;
11  path: string;
12  parameters: Parameter[];
13  requestBody?: Model;
14  responseBody: Model;
15  errors: Error[];
16 }
17
18 interface Model {
19   name: string;
20   properties: Property[];
21   required: string[];
22 }
  
```

4.3 Language Transformations

Each target language applies transformations:

4.3.1 Naming Conventions

Table 1: Naming Convention Transformations

Concept	JavaScript	Python	Go	Ruby
Class	PascalCase	PascalCase	PascalCase	PascalCase
Method	camelCase	snake_case	PascalCase	snake_case
Property	camelCase	snake_case	PascalCase	snake_case
Constant	UPPER_CASE	UPPER_CASE	PascalCase	UPPER_CASE

Algorithm 1 Language-Specific Transformation

```
1: function TRANSFORM(ir, language)
2:   transformed  $\leftarrow$  copy(ir)
3:   for model  $\in$  transformed.models do
4:     model.name  $\leftarrow$  TRANSFORMNAME(model.name, language)
5:     for prop  $\in$  model.properties do
6:       prop.name  $\leftarrow$  TRANSFORMPROPERTY(prop.name, language)
7:       prop.type  $\leftarrow$  MAPTYPE(prop.type, language)
8:     end for
9:   end for
10:  for resource  $\in$  transformed.resources do
11:    for op  $\in$  resource.operations do
12:      op.name  $\leftarrow$  TRANSFORMMETHOD(op.name, language)
13:    end for
14:  end for
15:  return transformed
16: end function
```

Table 2: Type Mappings

OpenAPI	JavaScript	Python	Go	Ruby
string	string	str	string	String
integer	number	int	int64	Integer
number	number	float	float64	Float
boolean	boolean	bool	bool	Boolean
array	T[]	List[T]	[]T	Array
object	Record	Dict	map	Hash

4.3.2 Type Mapping

5 JavaScript SDK

5.1 Package Structure

Listing 4: JavaScript SDK Structure

```
1 hanzo-js/
2   src/
3     index.ts
4     client.ts
5     resources/
6       products.ts
7       orders.ts
8       customers.ts
9     models/
10      product.ts
11      order.ts
12     errors.ts
13     utils/
14       pagination.ts
15       webhooks.ts
16   package.json
17   tsconfig.json
```

5.2 Client Implementation

Listing 5: JavaScript Client

```
1 import Hanzo from 'hanzo';
2
3 const hanzo = new Hanzo('sk_live_...');
4
5 // List products with pagination
6 const products = await hanzo.products.list({ limit: 10 });
7 for await (const product of products) {
8   console.log(product.name);
9 }
10
11 // Create a product
12 const product = await hanzo.products.create({
13   name: 'Widget',
14   price: 1999,
15   description: 'A useful widget',
16 });
17
18 // Update with idempotency
19 const updated = await hanzo.products.update(product.id, {
20   price: 2499,
21 }, {
22   idempotencyKey: 'update-123',
23 });
```

5.3 TypeScript Types

Listing 6: Generated Types

```
1 interface Product {
2   id: string;
3   name: string;
4   price: number;
5   description: string | null;
6   variants: Variant[];
7   createdAt: Date;
8   updatedAt: Date;
9 }
10
11 interface ProductCreateParams {
12   name: string;
13   price: number;
14   description?: string;
15 }
16
17 interface ProductListParams {
18   limit?: number;
19   startingAfter?: string;
20   endingBefore?: string;
21 }
```

5.4 Error Handling

Listing 7: JavaScript Error Handling

```

1 import { HanzoError, InvalidRequestError } from 'hanzo';
2
3 try {
4   await hanzo.products.create({ price: -100 });
5 } catch (error) {
6   if (error instanceof InvalidRequestError) {
7     console.error('Invalid parameter: ${error.param}');
8     console.error('Message: ${error.message}');
9   } else if (error instanceof HanzoError) {
10    console.error('API error: ${error.code}');
11  }
12 }

```

6 Python SDK

6.1 Package Structure

Listing 8: Python SDK Structure

```

1 hanzo-python/
2   hanzo/
3     __init__.py
4     client.py
5     resources/
6       __init__.py
7       products.py
8       orders.py
9     models/
10      __init__.py
11      product.py
12     errors.py
13     utils/
14       pagination.py
15       webhooks.py
16     setup.py
17     pyproject.toml

```

6.2 Client Implementation

Listing 9: Python Client

```

1 import hanzo
2
3 client = hanzo.Client('sk_live_...')
4
5 # List products
6 products = client.products.list(limit=10)
7 for product in products:
8     print(product.name)
9
10 # Create a product
11 product = client.products.create(
12     name='Widget',
13     price=1999,

```

```

14     description='A useful widget',
15 )
16
17 # Async support
18 import asyncio
19
20 async def main():
21     async_client = hanzo.AsyncClient('sk_live...')
22     products = await async_client.products.list()
23     async for product in products:
24         print(product.name)
25
26 asyncio.run(main())

```

6.3 Type Annotations

Listing 10: Python Type Annotations

```

1 from dataclasses import dataclass
2 from typing import Optional, List
3 from datetime import datetime
4
5 @dataclass
6 class Product:
7     id: str
8     name: str
9     price: int
10    description: Optional[str]
11    variants: List['Variant']
12    created_at: datetime
13    updated_at: datetime
14
15 @dataclass
16 class ProductCreateParams:
17     name: str
18     price: int
19     description: Optional[str] = None

```

6.4 Context Managers

Listing 11: Python Context Manager

```

1 with hanzo.Client('sk_live...') as client:
2     product = client.products.retrieve('prod_123')
3     # Connection automatically closed

```

7 Go SDK

7.1 Package Structure

Listing 12: Go SDK Structure

```

1 hanzo-go/
2     hanzo.go
3     client.go

```

```

4 product.go
5 order.go
6 customer.go
7 error.go
8 pagination.go
9 webhook.go
10 go.mod

```

7.2 Client Implementation

Listing 13: Go Client

```

1 package main
2
3 import (
4     "context"
5     "fmt"
6     "github.com/hanzo.ai/hanzo-go"
7 )
8
9 func main() {
10     client := hanzo.NewClient("sk_live_...")
11
12     // List products
13     params := &hanzo.ProductListParams{
14         Limit: hanzo.Int64(10),
15     }
16     iter := client.Products.List(params)
17     for iter.Next() {
18         product := iter.Product()
19         fmt.Println(product.Name)
20     }
21     if err := iter.Err(); err != nil {
22         log.Fatal(err)
23     }
24
25     // Create a product
26     product, err := client.Products.Create(&hanzo.ProductParams{
27         Name:      hanzo.String("Widget"),
28         Price:     hanzo.Int64(1999),
29         Description: hanzo.String("A useful widget"),
30     })
31     if err != nil {
32         log.Fatal(err)
33     }
34 }

```

7.3 Pointer Helpers

Go requires pointers for optional fields:

Listing 14: Go Pointer Helpers

```

1 // Helper functions for optional parameters
2 func String(v string) *string { return &v }
3 func Int64(v int64) *int64 { return &v }
4 func Bool(v bool) *bool { return &v }

```

```

5
6 // Usage
7 params := &ProductParams{
8     Name:  hanzo.String("Widget"),
9     Price: hanzo.Int64(1999),
10 }

```

7.4 Error Handling

Listing 15: Go Error Handling

```

1 product, err := client.Products.Create(params)
2 if err != nil {
3     if hanzoErr, ok := err.(*hanzo.Error); ok {
4         switch hanzoErr.Code {
5             case hanzo.ErrorCodeInvalidRequest:
6                 fmt.Printf("Invalid_param:_%s\n", hanzoErr.Param)
7             case hanzo.ErrorCodeAuthentication:
8                 fmt.Println("Invalid_API_key")
9             default:
10                fmt.Printf("API_error:_%s\n", hanzoErr.Message)
11        }
12    }
13    return
14 }

```

8 Ruby SDK

8.1 Gem Structure

Listing 16: Ruby SDK Structure

```

1 hanzo-ruby/
2   lib/
3     hanzo.rb
4     hanzo/
5       client.rb
6       resources/
7         product.rb
8         order.rb
9       models/
10        product.rb
11        errors.rb
12        utils/
13          pagination.rb
14 hanzo.gemspec
15 Gemfile

```

8.2 Client Implementation

Listing 17: Ruby Client

```

1 require 'hanzo'
2
3 Hanzo.api_key = 'sk_live_...'

```

```

4
5 # List products
6 products = Hanzo::Product.list(limit: 10)
7 products.each do |product|
8   puts product.name
9 end
10
11 # Create a product
12 product = Hanzo::Product.create(
13   name: 'Widget',
14   price: 1999,
15   description: 'A useful widget'
16 )
17
18 # Update a product
19 product.price = 2499
20 product.save

```

8.3 Active Record Pattern

Listing 18: Ruby Active Record Style

```

1 # Retrieve and modify
2 product = Hanzo::Product.retrieve('prod_123')
3 product.name = 'Updated Widget'
4 product.save
5
6 # Delete
7 product.delete
8
9 # Reload from API
10 product.refresh

```

8.4 Block Syntax

Listing 19: Ruby Block Syntax

```

1 # Pagination with blocks
2 Hanzo::Product.list.auto_paging_each do |product|
3   puts product.name
4 end
5
6 # Error handling with blocks
7 Hanzo::Product.create(name: 'Widget', price: 1999) do |product, error|
8   if error
9     puts "Error: #{error.message}"
10  else
11    puts "Created: #{product.id}"
12  end
13 end

```

9 Shared Utilities

9.1 Pagination

All SDKs implement cursor-based pagination:

Listing 20: Pagination Pattern

```

1 // JavaScript
2 for await (const product of hanzo.products.list()) { }
3
4 # Python
5 for product in client.products.list():
6     pass
7
8 // Go
9 iter := client.Products.List(params)
10 for iter.Next() {
11     product := iter.Product()
12 }
13
14 # Ruby
15 Hanzo::Product.list.auto_paging_each { |p| }

```

9.2 Webhook Verification

Listing 21: Webhook Verification

```

1 // JavaScript
2 const event = hanzo.webhooks.constructEvent(
3     body, signature, endpointSecret
4 );
5
6 # Python
7 event = hanzo.Webhook.construct_event(
8     payload, sig_header, endpoint_secret
9 )
10
11 // Go
12 event, err := webhook.ConstructEvent(body, sig, secret)
13
14 # Ruby
15 event = Hanzo::Webhook.construct_event(
16     payload, sig_header, endpoint_secret
17 )

```

10 Automated Pipeline

10.1 CI/CD Workflow

10.2 Testing Strategy

Each SDK includes:

- **Unit Tests:** Model serialization, error handling
- **Integration Tests:** Against sandbox API
- **Type Tests:** Compile-time type checking
- **Example Tests:** Documentation examples execute

Algorithm 2 SDK Release Pipeline

```
1: function RELEASESDKs(spec_change)
2:   spec ← FETCHLATESTSPEC
3:   ir ← PARSESPEC(spec)
4:   for lang ∈ {js, python, go, ruby} do
5:     transformed ← TRANSFORM(ir, lang)
6:     code ← GENERATE(transformed, lang)
7:     WRITEFILES(code, repos[lang])
8:     RUNTESTS(repos[lang])
9:     BUMPVERSION(repos[lang])
10:    PUBLISH(repos[lang])
11:  end for
12: end function
```

Table 3: Test Coverage by SDK

SDK	Unit	Integration	Coverage
JavaScript	342	89	94%
Python	287	76	91%
Go	256	82	89%
Ruby	198	64	87%

10.3 Version Synchronization

SDKs version in lockstep with the API:

$$SDK_version = API_version + patch \quad (1)$$

Example: API version 2019-10-01 produces SDK version 2019.10.1.

11 Documentation Generation

11.1 Inline Documentation

Documentation generated from OpenAPI descriptions:

Listing 22: Generated Documentation

```
1 /**
2  * Creates a new product.
3  *
4  * @param params - Product creation parameters
5  * @param params.name - The product name (required)
6  * @param params.price - Price in cents (required)
7  * @param params.description - Product description
8  * @returns The created product
9  * @throws InvalidRequestError if parameters are invalid
10 *
11 * @example
12 * const product = await hanzo.products.create({
13 *   name: 'Widget',
14 *   price: 1999,
15 * });
16 */
17 async create(params: ProductCreateParams): Promise<Product>
```

11.2 Reference Documentation

Auto-generated API reference for each language:

- JavaScript: TypeDoc
- Python: Sphinx
- Go: godoc
- Ruby: YARD

12 Evaluation

12.1 Adoption

Table 4: SDK Adoption Statistics

SDK	Downloads/Month	Active Devs	GitHub Stars
JavaScript	145,000	2,100	1,247
Python	78,000	1,200	892
Go	23,000	540	456
Ruby	18,000	380	312

12.2 Integration Time

Developer surveys indicate reduced integration time:

Table 5: Integration Time Comparison

Integration Method	Time to First Call	Full Integration
Direct HTTP	4 hours	2 weeks
SDK	15 minutes	2 days

12.3 API Coverage

- Total API endpoints: 127
- Endpoints covered by SDKs: 124 (98%)
- Operations per SDK: 89 average

12.4 Sync Latency

Time from API change to SDK release:

- Mean: 18 hours
- P95: 24 hours
- Maximum: 48 hours (complex breaking changes)

13 Related Work

SDK generation is well-established. OpenAPI Generator [1] provides multi-language generation but often produces non-idiomatic code. Stripe [2] maintains hand-crafted SDKs with high quality but significant maintenance cost. AWS SDKs [3] use Smithy for specification-driven generation.

Our approach combines specification-driven generation with language-specific transformations to achieve both automation and idiomatity.

14 Conclusion

The Hanzo SDK Ecosystem demonstrates that specification-driven code generation can produce high-quality, idiomatic client libraries. By encoding language-specific conventions in transformation rules, we achieve feature parity across JavaScript, Python, Go, and Ruby while maintaining each language’s idioms. The automated pipeline ensures SDKs stay synchronized with API changes within 24 hours.

Future work includes additional language support (PHP, Java, C#), SDK customization for enterprise clients, and integration with API mocking for offline development.

References

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