



The logo features the text "Fluently NoSQL" in a bold, yellow, sans-serif font. The letters are partially cut out by a large, semi-transparent 3D pyramid. The pyramid has a grey top face, a dark blue front face, a teal left face, and a purple right face. It is set against a dark navy blue background.

# Fluently NoSQL

# **Joe Smith**

**Site Reliability Engineer at Slack**

**@Yasumoto**

- Performance 🚗
- Efficiency 💰
- Reliability 💪
- Scalability ↗



# Agenda

- 🚧 Patient Road to Production
- 📦 DynamoDB
- 🌴 AWSSDKSwift
- 💧 Fluent DynamoDB



# Launching to Prod

A photograph of a rocket launching from a launch pad. The rocket is positioned vertically in the center-right of the frame. A large plume of white and orange smoke and fire erupts from its base, partially obscuring the lower part of the rocket. The background is a dark, cloudy sky. The overall scene conveys a sense of power and ascent.

Photo by SpaceX on Unsplash

A photograph of a dense forest reflected in a dark, still body of water. The trees, mostly evergreens, are silhouetted against a bright sky. Some deciduous trees show autumnal colors. The word "Ecosystem" is overlaid in large, bold, yellow letters.

# Ecosystem

Photo by Markus Spiske on Unsplash

# Introducing New Technology

# Roadmap



# Emergency Stop

1. What Loadtests are running right now?
2. How do I stop all loadtests NOW?

# All's Well – Loadtesting May Proceed

## Message

### Explanation Message

Please include a channel name so folks know where to go for more details.

[Initiate Emergency Stop!](#)

## Running Loadtests

Timestamp	Username	Hostname	Loadtest Tool
10/1/2019, 10:32:55 AM	jmsmith	SFO-M-JMSMITH02	api_blast: EKM Test

## Emergency Stop History

Username	Timestamp	Message	Is Incident Ongoing	Version
arka	9/26/2019, 2:10:58 PM	Incident cleared		24
arka	9/26/2019, 2:10:22 PM	this is paging for Database problems		23
jrodgers	9/26/2019, 1:08:29 PM	going to continue with #loadtest-private-channel-access-controls		22

# Data Structure – ServiceLock

1. **ServiceName**  always global
2. **Version**  A historical log
3. **IsIncidentOngoing**  the "red button"
4. **Username**  Who flipped the switch?
5. **Timestamp**  When?
6. **Message**  Where's the incident channel?

A silhouette of a person standing with arms raised against a vibrant sunset sky. The sky is filled with horizontal bands of orange, red, and yellow, transitioning into darker blues and purples at the top. The horizon line shows the silhouette of a mountain range or hills.

# End Goal

A dramatic photograph of a large industrial facility, possibly a factory or warehouse, engulfed in massive, intense flames. The fire is concentrated on the upper levels and roof, with thick, billowing smoke rising into the sky. The surrounding area appears to be a parking lot with some vehicles visible in the foreground.

# Low-risk Production Experience

Photo by Dawn Armfield on Unsplash



# Picking a Datastore (at Slack)

- MySQL
- Something Else

# DynamoDB

*Most of our services... store and retrieve data by primary key and do not require the **complex querying** and management functionality offered by an RDBMS.*

-- Dynamo Paper

# Key Concepts

1. Tables
2. Items & Attributes
3. Primary Keys

# Table

1. Name
2. Hash Key
3. Range Key
4. Capacity

# Items

Photo by Karen Vardazaryan on Unsplash

# Attributes (Values)

- Scalars
  - Single items
- Collections
  - Groups of values

# Scalar Values

- Binary
- Boolean
- Number
- Null
- String

# Collection Values

1. Binary Set
2. List
3. Map
4. Number Set
5. String Set

# **Primary Key**

1. Simple Primary Key – Hash Key

2. Composite Primary Key

1. Hash Key

2. Sort Key

# Scalars as Primary Keys

1. String
2. Numbers
3. Binary

# Data Structure – ServiceLock

1.  ServiceName ( String ) – Hash Key
2.  Version ( Int ) – Sort Key
3.  IsIncidentOngoing ( Bool )
4.  Username ( String )
5.  Timestamp( String )
6.  Message ( String )

```
resource "aws_dynamodb_table" "emergency_stop_service_lock" {
    name          = "emergency-stop-service-lock"
    read_capacity = 10
    write_capacity = 10
    hash_key      = "ServiceName"
    range_key     = "Version"

    attribute {
        name = "ServiceName"
        type = "S"
    }

    attribute {
        name = "Version"
        type = "N"
    }
}
```

Service Name	Version	Is Incident Ongoing	User name	Time stamp	Message
global	1	true	Jim	8/25/2019, 2:04:31 AM	Error!
global	2	false	Joe	8/27/2019, 7:13:40 PM	Fixed

Service Name	Version	Is Incident Ongoing	User name	Time stamp	Message
global	1	true	Jim	8/25/2019, 2:04:31 AM	Error!
global	2	false	Joe	8/27/2019, 7:13:40 PM	Fixed

# Scalability

Photo by Maria Molinero on Unsplash

<https://dynamodbguide.com>

**By Alex DeBrie**

# AWS SDK Swift

- Created by Yuki (@noppoMan)
- Major contributions from @jonnymacs and @adam-fowler

# Two Components

- aws-sdk-swift-core
- aws-sdk-swift

# AWS SDK Swift Core

# CredentialProvider

```
/// Protocol defining requirements for object providing AWS credentials
public protocol CredentialProvider {
    var accessKeyId: String { get }
    var secretAccessKey: String { get }
    var sessionToken: String? { get }
    var expiration: Date? { get }
}
```

# AWS SDK Swift Core – Hashing

-  CommonCrypto
  - or
  -  CAWSSDKOpenSSL
1. hmac – hash-keyed message authentication code
  2. sha256
  3. md5

# AWS SDK Swift Core – HTTPClient

```
public final class HTTPClient {  
    public struct Request {  
        var head: HTTPRequestHead  
        var body: Data = Data()  
    }  
  
    public struct Response {  
        let head: HTTPResponseHead  
        let body: Data  
        public func contentType() -> String?  
    }  
  
    public enum HTTPError: Error {  
        case malformedHead, malformedBody, malformedURL  
    }  
  
    public init(url: URL, eventGroup: EventLoopGroup)  
  
    public func connect(_ request: Request) -> EventLoopFuture<Response>  
  
    public func close(_ callback: @escaping (Error?) -> Void)  
}
```

```
public class AWSClient {  
    public enum RequestError: Error {  
        case invalidURL(String)  
    }  
  
    public var endpoint: String  
  
    public static let eventGroup: EventLoopGroup  
  
    public func signURL(url: URL,  
                        httpMethod: String,  
                        expires: Int = 86400) -> URL  
    ...
```

```
public func send<Output: AWSShape, Input: AWSShape>(
    operation operationName: String,
    path: String,
    httpMethod: String,
    input: Input) -> Future<Output> {
    return signer.manageCredential().thenThrowing { _ in
        let awsRequest = try self.createAWSRequest(
            operation: operationName,
            path: path,
            httpMethod: httpMethod,
            input: input
        )
        return try self.createNioRequest(awsRequest)
    }.then { nioRequest in
        return self.invoke(nioRequest)
    }.thenThrowing { response in
        return try self.validate(operation: operationName, response: response)
    }
}
```

```
public func send<Output: AWSShape, Input: AWSShape>(
    operation operationName: String,
    path: String,
    httpMethod: String,
    input: Input) -> Future<Output> {
    return signer.manageCredential().thenThrowing { _ in
        let awsRequest = try self.createAWSRequest(
            operation: operationName,
            path: path,
            httpMethod: httpMethod,
            input: input
        )
        return try self.createNioRequest(awsRequest)
    }.then { nioRequest in
        return self.invoke(nioRequest)
    }.thenThrowing { response in
        return try self.validate(operation: operationName, response: response)
    }
}
```

```
public func send<Output: AWSShape, Input: AWSShape>(  
    operation operationName: String,  
    path: String,  
    httpMethod: String,  
    input: Input) -> Future<Output> {  
    return signer.manageCredential().thenThrowing { _ in  
        let awsRequest = try self.createAWSRequest(  
            operation: operationName,  
            path: path,  
            httpMethod: httpMethod,  
            input: input  
        )  
        return try self.createNioRequest(awsRequest)  
    }.then { nioRequest in  
        return self.invoke(nioRequest)  
    }.thenThrowing { response in  
        return try self.validate(operation: operationName, response: response)  
    }  
}
```

# AWS SDK Swift Dynamo Client

1. AttributeValue
2. getItem / putItem
3. query

# AttributeValue

```
/// An attribute of type Binary. For example:  
/// "B": "dGhpcyB0ZXh0IGlzIGJhc2U2NC1lbmNvZGVk"  
public let b: Data?
```

```
/// An attribute of type Boolean. For example: "BOOL": true  
public let bool: Bool?
```

```
/// An attribute of type Number. For example: "N": "123.45"  
/// Numbers are sent across the network to DynamoDB as strings,  
/// to maximize compatibility across languages and libraries.  
/// However, DynamoDB treats them as number type attributes  
/// for mathematical operations.  
public let n: String?
```

```
/// An attribute of type Null. For example: "NULL": true  
public let null: Bool?
```

```
/// An attribute of type String. For example: "S": "Hello"  
public let s: String?
```

# AttributeValue

```
/// An attribute of type Binary Set. For example:
```

```
/// "BS": ["U3Vubnk=", "UmFpbnk=", "U25vd3k="]
```

```
public let bs: [Data]?
```

```
/// An attribute of type List. For example:
```

```
/// "L": [ {"S": "Cookies"} , {"S": "Coffee"}, {"N", "3.14159"} ]
```

```
public let l: [AttributeValue]?
```

```
/// An attribute of type Map. For example:
```

```
/// "M": {"Name": {"S": "Joe"}, "Age": {"N": "35"} }
```

```
public let m: [String: AttributeValue]?
```

```
/// An attribute of type Number Set. For example:
```

```
/// "NS": ["42.2", "-19", "7.5", "3.14"]
```

```
public let ns: [String]?
```

```
/// An attribute of type String Set. For example:
```

```
/// "SS": ["Giraffe", "Hippo" , "Zebra"]
```

```
public let ss: [String]?
```

```
public class AttributeValue: AWSShape {
    public init(b: Data? = nil, bool: Bool? = nil,
                bs: [Data]? = nil, l: [AttributeValue]? = nil,
                m: [String: AttributeValue]? = nil,
                n: String? = nil, ns: [String]? = nil,
                null: Bool? = nil, s: String? = nil,
                ss: [String]? = nil) {
        self.b = b
        self.bool = bool
        self.bs = bs
        self.l = l
        self.m = m
        self.n = n
        self.ns = ns
        self.null = null
        self.s = s
        self.ss = ss
    }
}
```

# Fetching a Single Item

```
/// The GetItem operation returns a set of attributes
/// for the item with the given primary key.
public func getItem(_ input: GetItemInput) -> Future<GetItemOutput> {
    return client.send(operation: "GetItem",
                       path: "/",
                       httpMethod: "POST",
                       input: input)
}
```

# GetItemInput

```
/// Determines the read consistency model  
public let consistentRead: Bool?
```

```
/// A map representing the primary key of the item to retrieve.  
public let key: [String: AttributeValue]
```

```
/// The name of the table containing the requested item.  
public let tableName: String
```

# Setting Items

```
/// Creates a new item, or replaces an old item with a new item.  
public func putItem(_ input: PutItemInput) -> Future<PutItemOutput> {  
    return client.send(operation: "PutItem",  
                       path: "/",  
                       httpMethod: "POST",  
                       input: input)  
}
```

# Setting Items

```
/// Creates a new item, or replaces an old item with a new item.  
public func putItem(_ input: PutItemInput) -> Future<PutItemOutput> {  
    return client.send(operation: "PutItem",  
                       path: "/",  
                       httpMethod: "POST",  
                       input: input)  
}
```

## PutItemInput

```
/// A map of attribute name/value pairs.  
public let item: [String: AttributeValue]
```

```
/// Use ReturnValues if you want to get the item attributes  
/// as they appeared before they were updated  
public let returnValues: ReturnValue?
```

```
/// The name of the table to contain the item.  
public let tableName: String
```

# Querying for Multiple Items

```
/// The Query operation finds items based on primary key values.  
public func query(_ input: QueryInput) -> Future<QueryOutput> {  
    return client.send(operation: "Query",  
                       path: "/",  
                       httpMethod: "POST",  
                       input: input)  
}
```

```
/// One or more substitution tokens for attribute names  
/// in an expression.
```

```
public let expressionAttributeNames: [String: String]?
```

```
/// One or more values that can be substituted in an expression.
```

```
public let expressionAttributeValues: [String: AttributeValue]?
```

```
/// The condition that specifies the key values for items to  
/// be retrieved by the Query action.
```

```
public let keyConditionExpression: String?
```

```
let nowDate = Date()
let earlierDate = now.addingTimeInterval(-60.0 * 60.0)

let now = formatter.string(from: nowDate)
let earlier = formatter.string(from: earlierDate)

let expressionAttributeNames = [
    "#S": "ServiceName",
    "#T": "Timestamp"]
let expressionAttributeValues = [
    ":global": DynamoDB.AttributeValue(s: "global"),
    ":then": DynamoDB.AttributeValue(s: earlier),
    ":now": DynamoDB.AttributeValue(s: now)]

let keyConditionExpression = "#S = :global AND #T BETWEEN :then AND :now"
```

# AWS SDK Swift Dynamo Client

1. AttributeValue
2. getItem / putItem
3. query

A large, dark, textured rock formation, possibly a cliff or mountain, is silhouetted against a bright, cloudy sky. The rock's surface is rough and layered, with deep shadows and highlights from the surrounding light.

# History of Changes

Photo by Daniel H. Tong on Unsplash

Service Name	Version	Is Incident Ongoing	User name	Time stamp	Message
global	1	true	Jim	8/25/2019, 2:04:31 AM	Error!
global	2	false	Joe	8/27/2019, 7:13:40 PM	Fixed

Service Name	Version	Is Incident Ongoing	User name	Time stamp	Message
global	1	true	Jim	8/25/2019, 2:04:31 AM	Error!
global	2	false	Joe	8/27/2019, 7:13:40 PM	Fixed

<b>Service Name</b>	<b>Version</b>	<b>Is Incident Ongoing</b>	<b>Incident User name</b>	<b>Time stamp</b>	<b>Message</b>	<b>Current</b>
global	0	false	Joe	8/27/2019 , 7:13:40 PM	Fixed	2
global	1	true	Jim	8/25/2019 , 2:04:31 AM	Error!	
global	2	false	Joe	8/27/2019 , 7:13:40 PM	Fixed	

<b>Service Name</b>	<b>Version</b>	<b>Is Incident Ongoing</b>	<b>Incident User name</b>	<b>Time stamp</b>	<b>Message</b>	<b>Current</b>
global	0	false	Joe	8/27/2019 , 7:13:40 PM	Fixed	2
global	1	true	Jim	8/25/2019 , 2:04:31 AM	Error!	
global	2	false	Joe	8/27/2019 , 7:13:40 PM	Fixed	

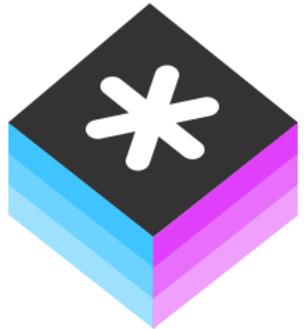


# Denormalized Data

# Fluent DynamoDB

# 💧 Fluent 3 Concepts

1. 📦 Database
2. ⚡ DatabaseConnection
3. 😻 Provider



**Fluent**



# Database

```
public protocol Database {  
  
    associatedtype Connection: DatabaseConnection  
  
    /// Creates a new `DatabaseConnection` that will perform  
    /// async work on the supplied `Worker`.  
    func newConnection(on worker: Worker) -> Future<Connection>  
}
```

```
public final class DynamoDatabase: Database {
    public typealias Connection = DynamoConnection
    private let config: DynamoConfiguration

    public init(config: DynamoConfiguration) {
        self.config = config
    }

    internal func openConnection() -> DynamoDB {
        return DynamoDB(accessKeyId: config.accessKeyId,
                        secretAccessKey: config.secretAccessKey,
                        region: config.region,
                        endpoint: config.endpoint)
    }

    public func newConnection(on worker: Worker) -> EventLoopFuture<DynamoConnection> {
        do {
            let conn = try DynamoConnection(database: self, on: worker)
            return worker.future(conn)
        } catch {
            return worker.future(error: error)
        }
    }
}
```



# DatabaseConnection

```
public protocol DatabaseConnection: DatabaseConnectable, Extendable {  
    /// This connection's associated database type.  
    associatedtype Database: DatabaseKit.Database  
    where Database.Connection == Self  
  
    /// If `true`, this connection has been closed and is no  
    /// longer valid.  
    /// This is used by `DatabaseConnectionPool` to prune  
    /// inactive connections.  
    var isClosed: Bool { get }  
  
    /// Closes the `DatabaseConnection`.  
    func close()  
}
```

```
public final class DynamoConnection: DatabaseConnection {
    public typealias Database = DynamoDatabase

    public var isClosed: Bool {
        return self.handle.isClosed()
    }

    public func close() {
        self.handle.close()
    }

    /// Reference to parent `DynamoDatabase` that created this connection.
    private let database: DynamoDatabase

    internal private(set) var handle: DynamoDB!

    internal init(database: DynamoDatabase, on worker: Worker) throws {
        self.database = database
        self.eventLoop = worker.eventLoop
        self.handle = database.openConnection()
    }
}
```

# Creating a Connection

A photograph showing two hands reaching across a body of water towards each other. The hand on the left is reaching from the top left, and the hand on the right is reaching from the bottom right. Both hands are open, palms facing each other. The background is a dark blue sky and water, suggesting it might be dusk or dawn. The lighting is warm, coming from the sides of the hands.

A photograph by Phix Nguyen on Unsplash.

**Photo by Phix Nguyen on Unsplash**

```
public struct DatabaseIdentifier<D: Database>: Equatable,  
    Hashable, CustomStringConvertible, ExpressibleByStringLiteral {  
    /// The unique id.  
    public let uid: String  
  
    /// See `CustomStringConvertible`.  
    public var description: String {  
        return uid  
    }  
  
    /// Create a new `DatabaseIdentifier`.  
    public init(_ uid: String) {  
        self.uid = uid  
    }  
  
    /// See `ExpressibleByStringLiteral`.  
    public init(stringLiteral value: String) {  
        self.init(value)  
    }  
}
```

```
extension DatabaseIdentifier {  
    /// Default identifier for `DynamoDatabase`.  
    public static var dynamo: DatabaseIdentifier<DynamoDatabase> {  
        return "dynamo"  
    }  
}
```

```
// Capable of creating connections to identified databases.  
public protocol DatabaseConnectable: Worker {  
  
    func databaseConnection<Database>(  
        to database: DatabaseIdentifier<Database>?) ->  
    Future<Database.Connection>  
  
}
```

# DatabaseQueryable



```
public enum DynamoQueryAction {  
    case set, get, delete, filter  
}  
  
/// 🔎 A DynamoDB operation  
public struct DynamoQuery {  
    /// 📜 Note this is a var so `get/set` can be flipped easily if desired  
    public var action: DynamoQueryAction  
  
    /// 🍴 The name of the table in DynamoDB to work on  
    public let table: String  
  
    /// 💰 Which value(s) to perform the action upon  
    public let keys: [DynamoValue]  
}
```

```
/// 🔑 Values to uniquely identify an item stored in a DynamoDB Table
public struct DynamoValue: Codable, Equatable {

    public enum Attribute: Codable, Equatable {
        case mapping([String: Attribute])
        case null(Bool)
        case stringSet([String])
        case binary(Data)
        case string(String)
        case list([Attribute])
        case bool(Bool)
        case numberSet([String])
        case binarySet([Data])
        /// We send over all numbers to Dynamo as Strings, and cannot use Numeric
        case number(String)
    }
}
```

```
public func query(_ query: Query, _ handler: @escaping (Output) throws -> ()) -> Future<Void> {
    switch query.action {
        case .get:
            let inputItem = DynamoDB.GetItemInput(
                key: requestedKey, tableName: query.table)
            return self.handle.getItem(inputItem).map { output in
                return try handler(Output(attributes: output.item))
            }
        case .set:
            let inputItem = DynamoDB.PutItemInput(item: requestedKey, returnValues: .allOld, tableName: query.table)
            return self.handle.putItem(inputItem).map { output in
                return try handler(Output(attributes: output.attributes))
            }
        case .delete:
            let inputItem = DynamoDB.DeleteItemInput(
                key: requestedKey, returnValues: .allOld, tableName: query.table)
            return self.handle.deleteItem(inputItem).map { output in
                return try handler(DynamoValue(attributes: output.attributes))
            }
        case .filter:
            return self.eventLoop.newFailedFuture(error: DynamoConnectionError.notImplementedYet)
    }
} catch {
    return self.eventLoop.newFailedFuture(error: error)
}
```

```
case .set:  
    let inputItem = DynamoDB.PutItemInput(item: requestedKey,  
                                         returnValues: .allOld,  
                                         tableName: query.table)  
  
    return self.handle.putItem(inputItem).map { output in  
        return try handler(DynamoValue(attributes: output.attributes))  
    }
```



# Provider

```
public protocol Provider {  
    /// Register all services you would like to provide the `Container` here.  
    ///  
    ///     services.register(RedisCache.self)  
    ///  
    func register(_ services: inout Services) throws  
  
    /// Called before the container has fully initialized.  
    func willBoot(_ container: Container) throws -> Future<Void>  
  
    /// Called after the container has fully initialized and after `willBoot(_:)`.  
    func didBoot(_ container: Container) throws -> Future<Void>  
}
```

```
/// 💧 The Provider expected to be registered to easily allow
/// usage of DynamoDB from within a Vapor application
public struct FluentDynamoDBProvider: Provider {
    public func register(_ services: inout Services) throws {
        try services.register(FluentProvider())
        services.register(DynamoConfiguration.self)
        services.register(DynamoDatabase.self)
        var databases = DatabasesConfig()
        databases.add(database: DynamoDatabase.self, as: .dynamo)
        services.register(databases)
    }

    public func didBoot(_ container: Container) throws -> EventLoopFuture<Void> {
        return .done(on: container)
    }
}
```

```
try services.register(FluentDynamoDBProvider())

var databases = DatabasesConfig()

let credentialsPath = Environment.get("CREDENTIALS_FILENAME") ?? "/etc/emergency-stop.json"
let creds = awsCredentials(path: credentialsPath)
let endpoint = Environment.get("ENVIRONMENT") == "local" ? "http://localhost:8000" : nil

let dynamoConfiguration = DynamoConfiguration(accessKeyId: creds.accessKey,
                                              secretAccessKey: creds.secretKey,
                                              endpoint: endpoint)

let dynamo = DynamoDatabase(config: dynamoConfiguration)
databases.add(database: dynamo, as: .dynamo)
services.register(databases)
```

```
struct ServiceLock: Codable {  
    public let serviceName: String  
    public var version: Int?  
    public var currentVersion: Int?  
    public let isIncidentOngoing: Bool  
    public let username: String  
    public let timestamp: Date  
    public let message: String  
}
```

```
extension ServiceLock: Content { }
```

```
/// Write a ServiceLock to DynamoDB
///
/// - Returns:
///     An `EventLoopFuture` used to indicate success or failure
public func write(on worker: Request) -> EventLoopFuture<[DynamoValue]> {

    let key = self.dynamoFormat()

    let query = DynamoQuery(action: .set,
                           table: "limit-break-emergency-stop",
                           keys: [key])

    return worker.databaseConnection(to: .dynamo)
        .flatMap { connection in
            connection.query(query)
        }
}
```



```
router.post { req -> Future<View> in
    return try req.content.decode(Update.self).flatMap { update in
        return ServiceLock.read(on: req,
            serviceName: ServiceNames.global,
            version: 0).flatMap { latestLock in
                let lock = ServiceLock(serviceName: latestLock.serviceName,
                    version: latestLock.currentVersion! + 1,
                    currentVersion: nil,
                    isIncidentOngoing: update.isIncidentOngoing,
                    username: username,
                    timestamp: Date(),
                    message: update.message)
                return lock.write(on: req)
            }
        }
    }
}
```



Photo by Seth Reese on Unsplash

# Next

1.  Publish AWSSDKSwift 4.0.0
  1.  Uses NIO 2.0
2.  Create DynamоКit with NIO 2.0
3.  Convert FluentDynamoDB to Fluent 4
4.  Upgrade DynamoModel
5.  Better integration with swift-log and swift-metrics

# Thank you!

- ⚡ Emergency Stop
- 📦 DynamoDB
- 🌴 AWSSDKSwift
- 💧 Fluent DynamoDB

<https://github.com/Yasumoto/fluent-dynamodb>