

Kotlin JSON-RPC 2.0 Design

Abstract

This document describes the design of a Kotlin implementation of JSON-RPC 2.0, including core data models, serialization strategies, transport abstractions, and API considerations.

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1. Overview

This document describes a Kotlin model and client/server API for JSON-RPC 2.0. The goal is to provide a type-safe, protocol-correct representation of JSON-RPC messages.

Transport mechanisms, authentication, batching strategies, and method-specific behavior are intentionally excluded and left to higher-level implementations.

2. Conventions

The key words "MUST", "MUST NOT", "SHOULD", "SHOULD NOT" and "MAY" in this document are to be interpreted as described in RFC 2119.

3. Serialization Strategy

Implementation SHOULD use the core library `kotlinx.serialization`, since it is part of the core libraries it is well-tested and reliable.

It also provides classes like `JsonElement` or `JsonPrimitive` which allows the variable structures of JSON objects and still allowing easy serialization/deserialization.

All examples in this document assume the use of `kotlinx.serialization`. Alternative serialization frameworks may be used at the implementer's discretion.

4. Core Data Model

4.1. Base Message Model

```
sealed interface JsonRpcObject {  
    val jsonrpc: String?  
}
```

Because JSON-RPC 2.0 enforces a strict structure and a closed set of types for RPC calls, a sealed interface was used to restrict subclass declarations to the same module. The interface defines the `jsonrpc` property, which is mandatory for all JSON-RPC 2.0 objects but set nullable to be able to use it with 1.0. For more information, refer to Section [Backward Compatibility](#) (Section 8).

To continue this restriction the interface is only implemented using data classes since they are final by default.

4.2. Request & Notification

```
data class JsonRpcRequest (
    override val jsonrpc: String?,
    val method: String,
    val params: JsonElement? = null,
    val id: JsonPrimitive? = null
) : JsonRpcObject
```

Since the Section 4 of [JSON-RPC 2.0 \[JSON-RPC-2.0\]](#) defines the id field to be either a string or a number, implementations MUST represent it as a `JsonPrimitive`. This is possible because the id is not otherwise accessed and is passed through unchanged in the response. Because `JsonPrimitive` also allows boolean values and special null values, implementations MUST perform validations during the initialization of the object to ensure that only strings or numbers are accepted.

As defined in Section 4.1 of the [JSON-RPC 2.0 \[JSON-RPC-2.0\]](#) the difference between a request and a notification is the existence of the id. This is modeled by making the id property nullable, while enforcing the correct usage through higher-level APIs. The option to have a separate class for notifications was considered. See Section [Notification Handling \(Section 9.2\)](#).

Per the specification, parameters MAY be passed either by position or by name, corresponding to a JSON array or object respectively. To support both forms, parameters are represented using `JsonElement`. Again validations are applied to ensure that only `JsonObject` and `JsonArray` values are accepted, as primitive values are not valid parameters. The idea to use stronger types for the parameters was considered, see Section [Request Parameter Type \(Section 9.1\)](#).

4.3. Response

```
data class JsonRpcResponse (
    override val jsonrpc: String?,
    val result: JsonElement? = null,
    val error: JsonRpcError? = null,
    val id: JsonPrimitive? = null
) : JsonRpcObject
```

The result property MUST be represented as a `JsonElement` whose value is server-defined.

As defined in Section 5 of [JSON-RPC 2.0 \[JSON-RPC-2.0\]](#) either the result or error property MUST be exclusively set. This MUST be validated at initialization as well.

4.4. Error Model

```
data class JsonRpcError (  
    val code: Long,  
    val message: String,  
    val data: JsonElement? = null  
)
```

The error code is represented as a Long, since the code MUST be an integer as defined in Section 5.1 of [JSON-RPC 2.0 \[JSON-RPC-2.0\]](#). Using Long accommodates the full integer range representable by a JSON number, as defined in [RFC8259].

JsonElement was used to allow primitive and structural values for the data property and made nullable as defined in Section 5.1 of [JSON-RPC 2.0 \[JSON-RPC-2.0\]](#).

4.5. Validations

Structural invariants that apply to individual message instances are validated during object initialization. Context-dependent validations, such as request-response correlation or batch semantics, are enforced at higher protocol layers. This separation allows malformed messages to be represented explicitly and reported using standard JSON-RPC error responses.

5. Client API Design

```
interface JsonRpcClient {  
    fun <T> request(  
        method: String,  
        parameters: JsonElement? = null,  
        id: JsonPrimitive? = null,  
        serializer: KSerializer<T>  
    ): T  
  
    fun notify(  
        method: String,  
        parameters: JsonElement? = null  
    )  
}
```

The client SHOULD expose two distinct methods: one for JSON-RPC requests and one for JSON-RPC notifications. This separation provides a clear distinction between request and notification semantics and avoids the need for additional runtime checks to differentiate between RPC call types.

Each method SHOULD expose all possible properties of the respective RPC call type.

A notification MUST NOT include the id property. If an id is exposed, it MUST be ignored. This could occur if a `JsonRpcRequest` object was passed directly instead of passing the properties as parameters separately. This design option was considered as well. See Section [Client Method Parameters](#) (Section 9.3).

5.1. Request Method

The id parameter SHOULD be nullable, as the id SHOULD NOT be used for direct logic and MAY be generated by the request method. To allow user-defined logic, the id MAY be explicitly provided by the user.

The request method MAY omit the id parameter and manage request identifiers internally.

The method SHOULD return the expected generic type directly and therefore SHOULD accept a `KSerializer` capable of deserializing the result property. This allows the user to work with the result object directly without additional logic. Since the user does not have access to the error object, the method MUST propagate errors to the caller.

6. Server API Design

```
interface JsonRpcServer {
    fun <P, R> register(
        method: String,
        paramsDeserializer: KSerializer<P>,
        resultSerializer: KSerializer<R>,
        handler: suspend (P) -> R
    )

    fun <P> registerNotification(
        method: String,
        paramsDeserializer: KSerializer<P>,
        handler: suspend (P) -> Unit
    )

    fun receiveRpcCall(
        request: JsonRpcRequest
    ): JsonRpcResponse?
}
```

The server SHOULD have the possibility to register RPC methods. The method SHOULD be registered with a handler lambda function, which accepts one parameter.

Since the RPC method can receive multiple parameters the params property from `JsonRpcRequest` SHOULD be converted into the parameter type. In case of the named parameters it is straight forward and the `JsonElement` can be deserialized directly into the parameter type. For positional parameters reflection SHOULD be used to map the elements of the `JsonArray` to the parameter type. Thus the order of the parameter should correlate to the order of the properties of the parameter class.

The server SHOULD have two registration functions to differentiate between requests and notifications. Since the notification lambda function SHOULD NOT return a result. With that no serializer for the result is needed.

The server **MUST** implement a method which receives the RPC calls and then calls the corresponding method. The method **MUST** validate the received RPC call before handing it over to the handler.

The `receiveRpcCall` method **MUST** validate all possible errors mentioned in Section 5.1 of [JSON-RPC 2.0 \[JSON-RPC-2.0\]](#).

The `receiveRpcCall` method **MUST** locate the target method using the registered method name and invoke it via the corresponding handler with the deserialized parameters.

When handling a request, a `JsonRpcResult` object **MUST** be created and returned. If the call succeeds, this object **MUST** contain the serialized result using the `resultSerializer`. If an error occurs, it **MUST** instead contain a `JsonRpcError` describing the failure.

7. Batch Requests

To accommodate batch requests the client API **MUST** be extended by a method which accepts a `List<JsonRpcRequest>`. To still have abstract methods for adding requests and notifications an `BatchRequestBuilder` **SHOULD** be added.

```
interface BatchRequestBuilder {  
    fun addRequest(  
        method: String,  
        parameters: JsonElement? = null,  
        id: JsonPrimitive? = null  
    )  
  
    fun addNotification(  
        method: String,  
        parameters: JsonElement? = null  
    )  
}
```

TODO

8. Backward Compatibility

In JSON-RPC 1.0 the property `jsonrpc` is not defined and therefore not mandatory. To accommodate this the `jsonrpc` property **SHOULD** be nullable. This allows the client and server to set it to null.

The JSON-RPC 1.0 also only allows parameters to be passed by position. So the client **SHOULD** validate the parameter type upon calling a method to ensure this.

9. Alternatives Considered

9.1. Request Parameter Type

It was considered to represent request parameters using two properties, depending on whether they were passed by position or by name. This would have been represented by a `Map<String, JsonObject>` for named parameters and a `List<JsonObject>` for positional parameters. But the need for a `kotlinx.serialization` class still remains, and thus the class `JsonElement` is used, which already summarizes these possibilities.

9.2. Notification Handling

The idea the use an separate data class for notifications was considered.

```
data class JsonRpcNotification (
    override val jsonrpc: String,
    val method: String,
    val params: JsonElement? = null
) : JsonRpcObject
```

This would allow stricter type handling in the later design of the API. But this also complicates the case of batch request since they may include request and notifications within one array.

Ultimately this idea was tossed due to the limited benefits. This results in additional validation that needs to be added later on, but since validation is required anyway, this approach mainly introduces additional complexity.

9.3. Client Method Parameters

An alternative design was considered where client API methods accept a single `JsonRpcRequest` object rather than individual parameters. This would allow the request and notify methods to share a common signature and give callers more flexibility in how requests are constructed.

However, exposing `JsonRpcRequest` at the API boundary would require users to work directly with protocol-level details, such as assigning request identifiers and specifying the protocol version. This increases the risk of constructing invalid messages and the need for more validations.

To avoid exposing protocol-specific properties such as `jsonrpc` and `id`, and to prevent invalid states by construction, the client API instead accepts method names and parameters directly.

10. References

[JSON-RPC-2.0] Group, J. W., "JSON-RPC 2.0 Specification", URL <https://www.jsonrpc.org/specification>, 2010.

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