An introduction to ECLIPSE LMOS

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DEUTSCHE TELEKOM

ECLIPSE
INCUBATION

ABOUT ME

Robert Winkler

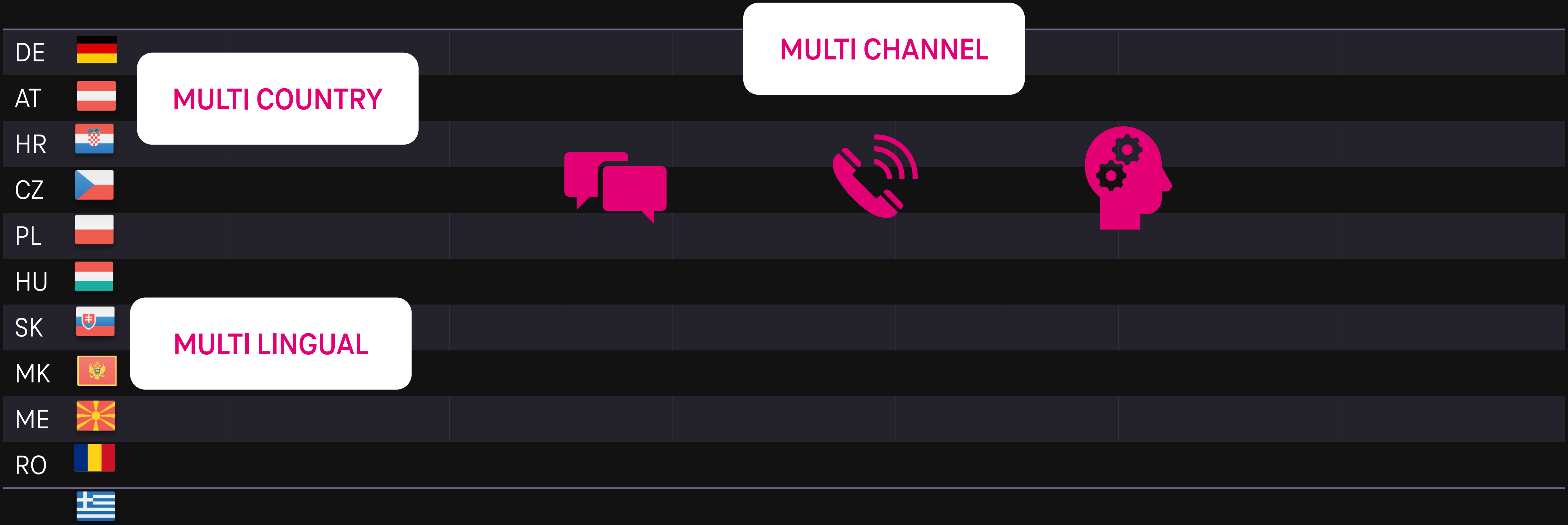
- Creator of Resilience4J

- Committer to Eclipse ThingWeb and Eclipse LMOS

- Built distributed systems, IoT & Conversational AI systems at scale

FRAGMAGENTA: Problem Space

How do you bring GenAI to solve Sales & Service Use cases across



DE

AT

HR

CZ

PL

HU

SK

MK

ME

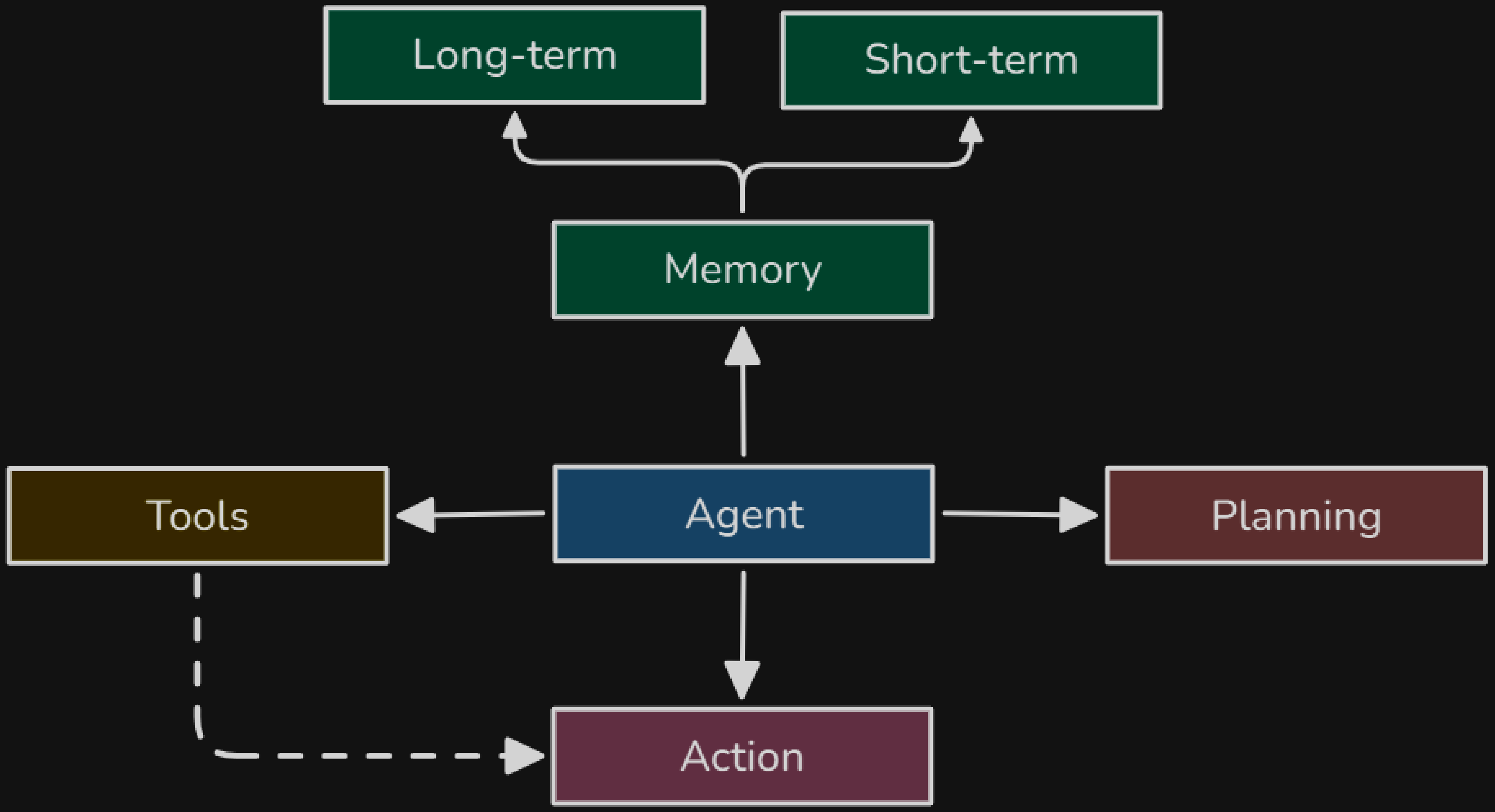
RO

MULTI COUNTRY

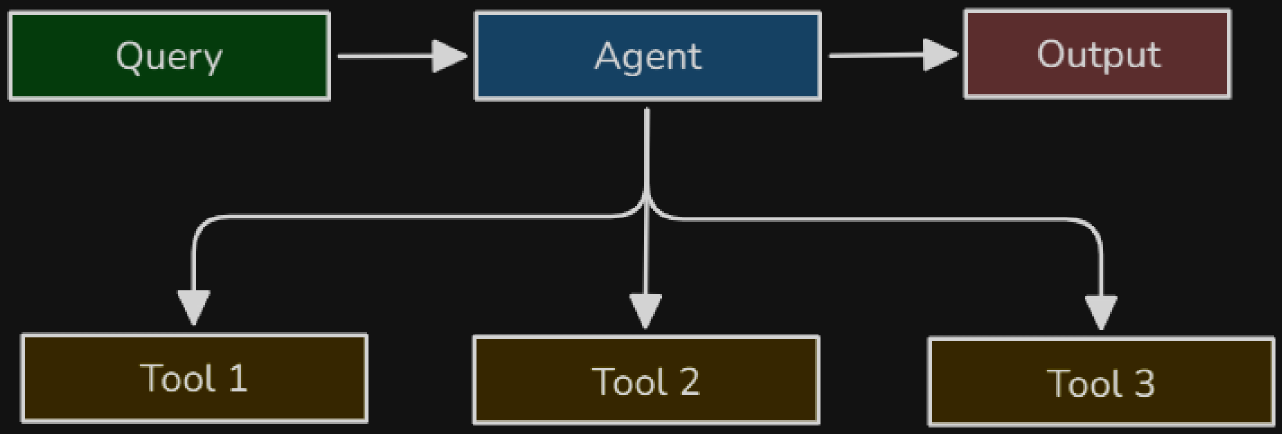
MULTI LINGUAL

MULTI CHANNEL

Single Agent



Single Agent



Query

Agent

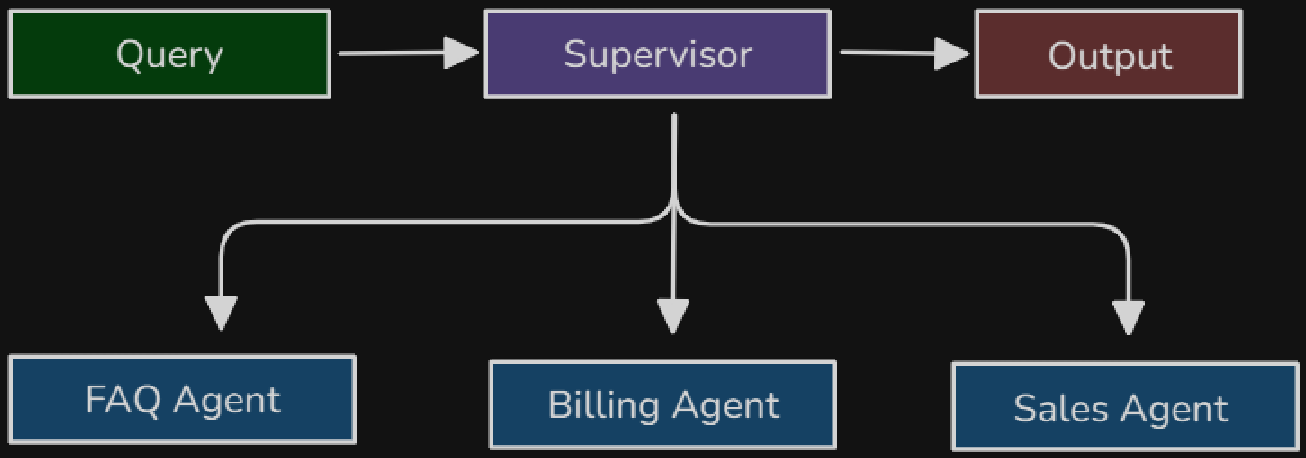
Output

Tool 1

Tool 2

Tool 3

Multi Agent System



Query

Supervisor

Output

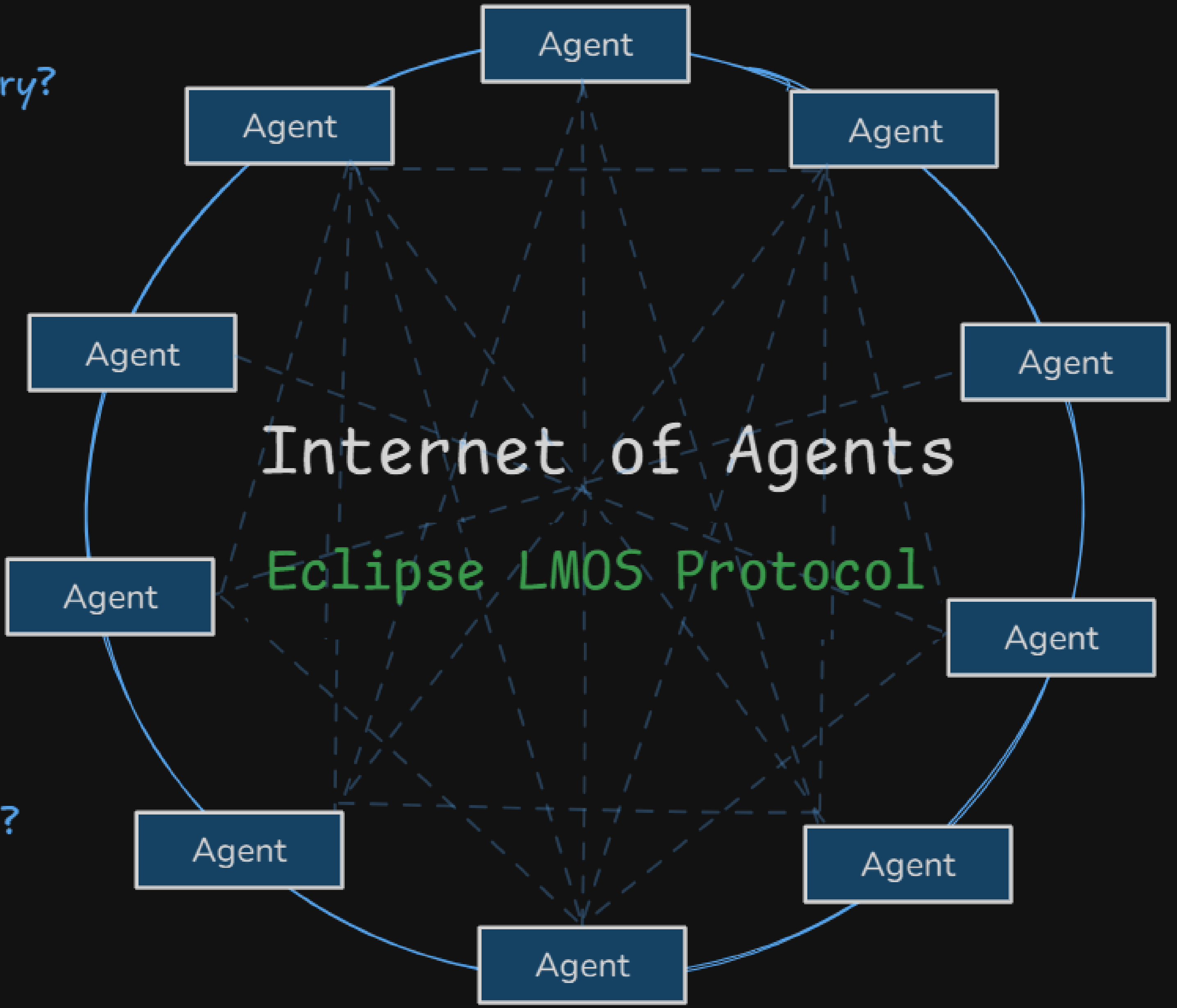
FAQ Agent

Billing Agent

Sales Agent

Internet of Agents

Eclipse LMOS Protocol



Discovery?

Connectivity?

Interoperability?

Versioning?

Metadata?

Security?

Grouping?

Canary rollouts?

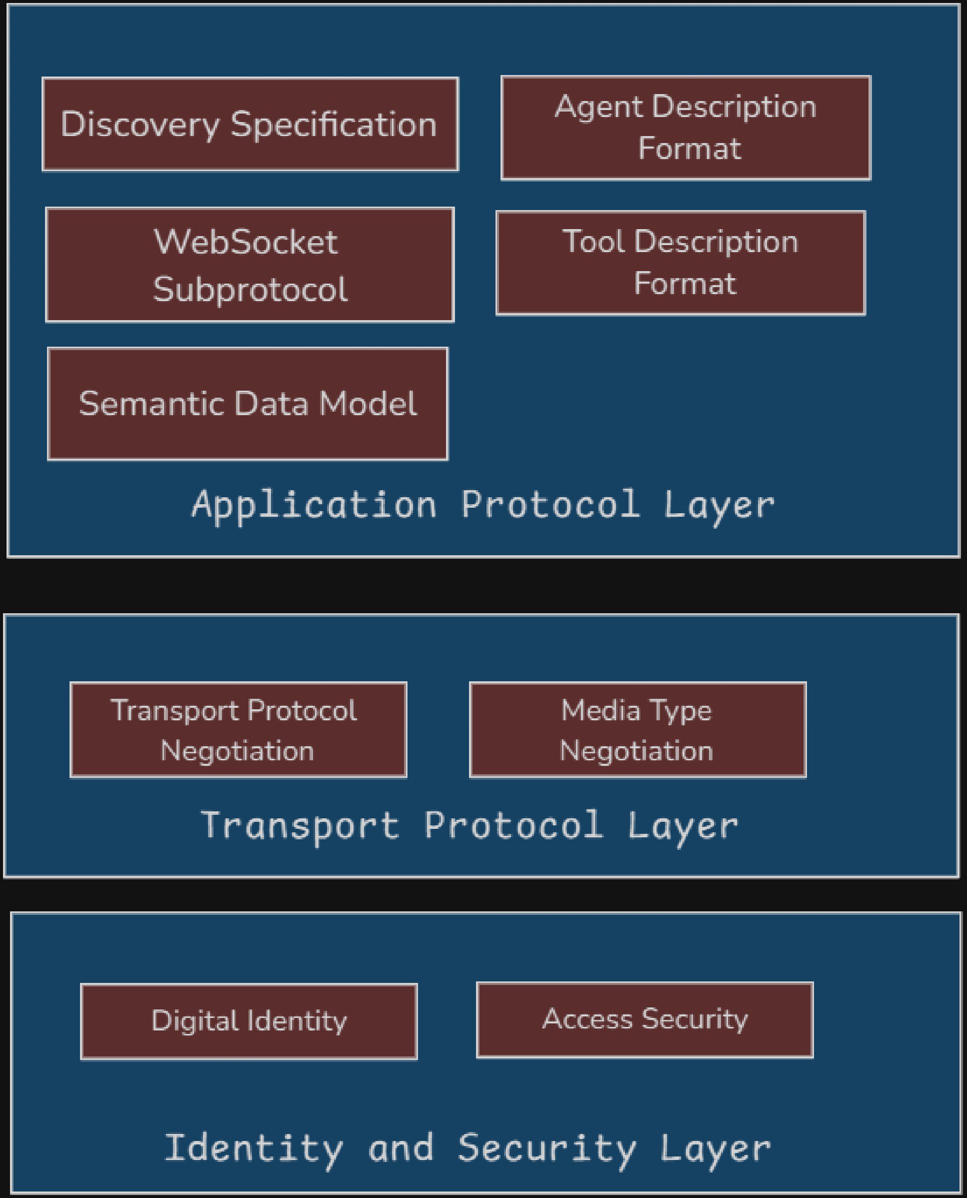
Enable Agents to discover, connect and collaborate

ECLIPSE LMOS Protocol

- Semantic-based Agent and Tool descriptions and data model
- Discoverable Agents and Tools
- Interoperable communication protocol

- Dynamic protocol negotiation

- Authentication, Authorization and end-to-end encrypted communication based on W3C standards.



Discovery Specification

Agent Description Format

WebSocket Subprotocol

Tool Description Format

Semantic Data Model

Application Protocol Layer

Transport Protocol Negotiation

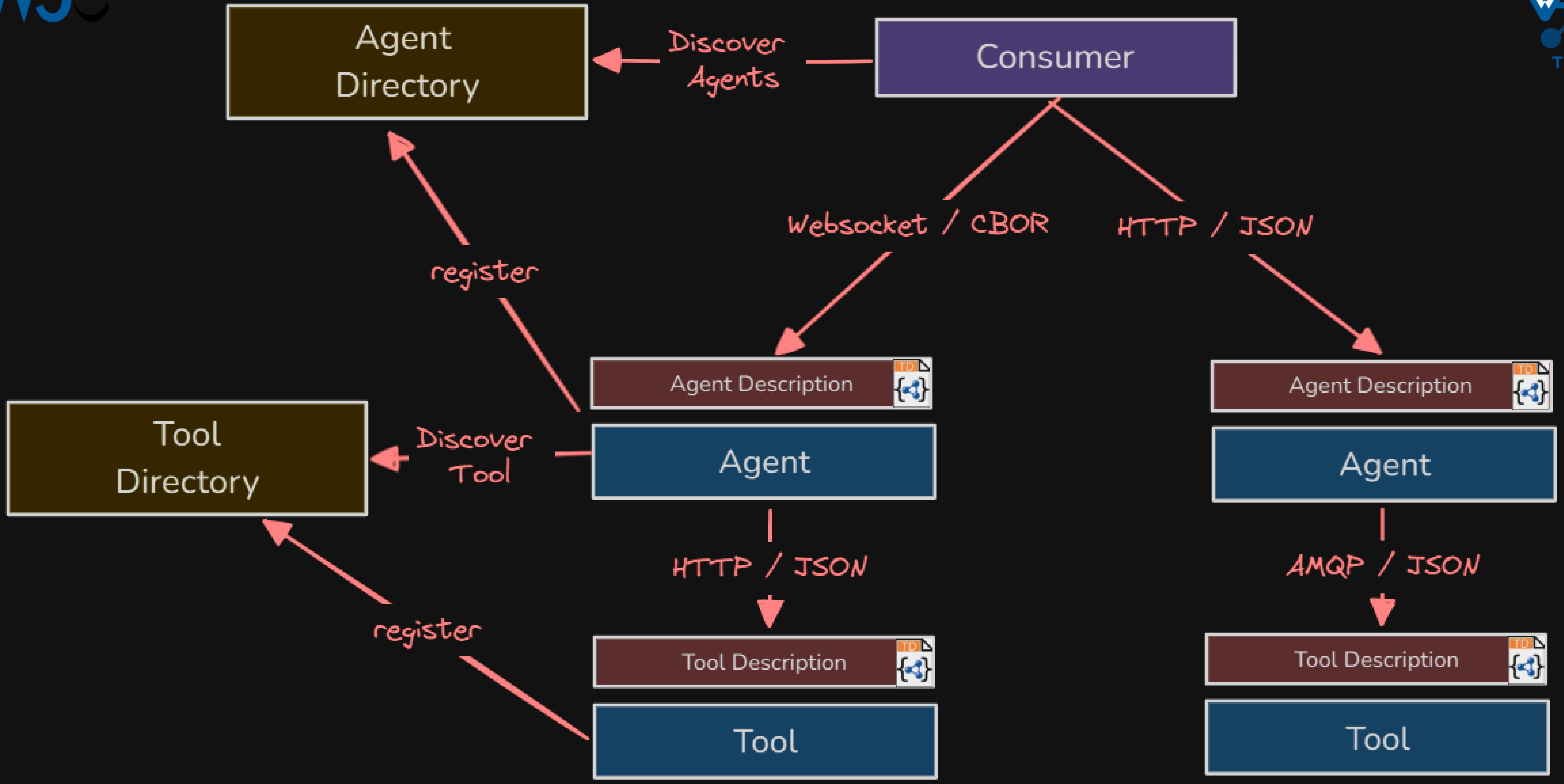
Media Type Negotiation

Transport Protocol Layer

Digital Identity

Access Security

Identity and Security Layer

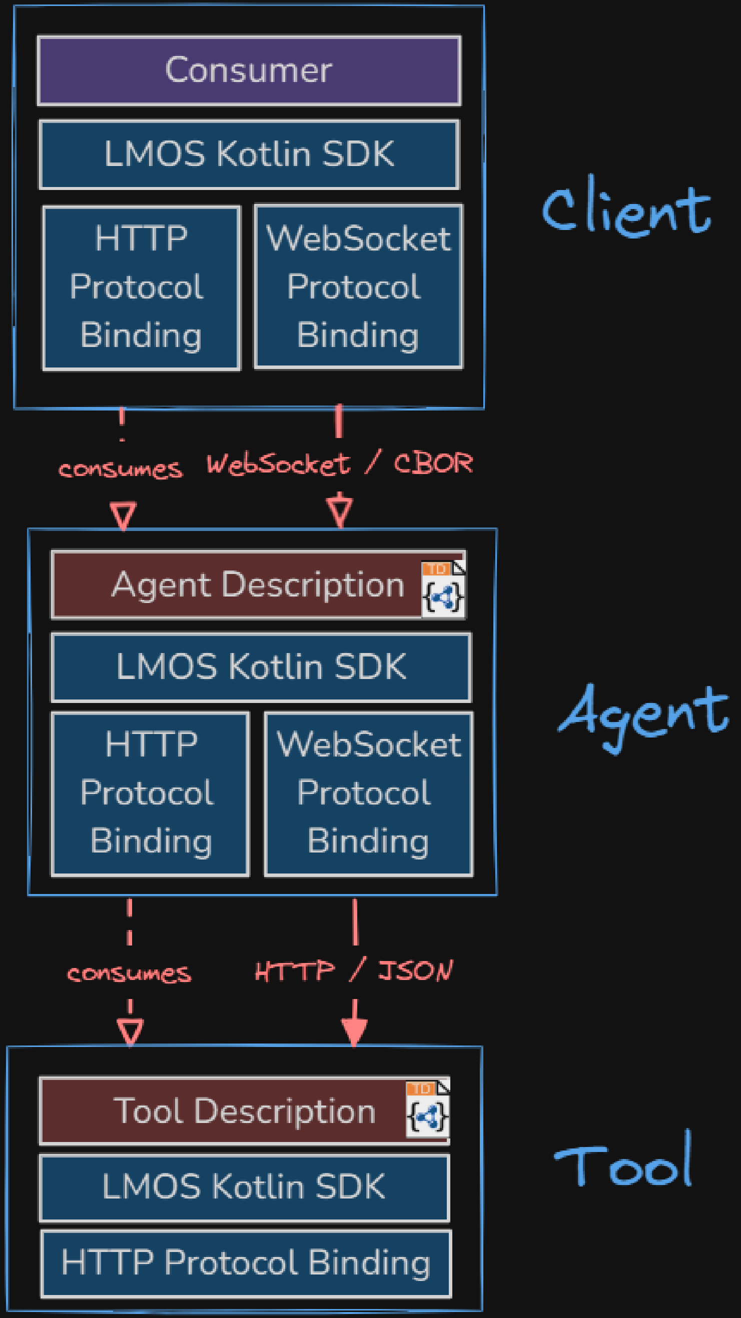

Agent Directory
Discover Agents
Consumer
Websocket / CBOR
HTTP / JSON
register
Agent Description
Agent Description
Tool Directory
Discover Tool
Agent
Agent
HTTP / JSON
AMQP / JSON
register
Tool Description
Tool Description
Tool
Tool

Discovery & Communication

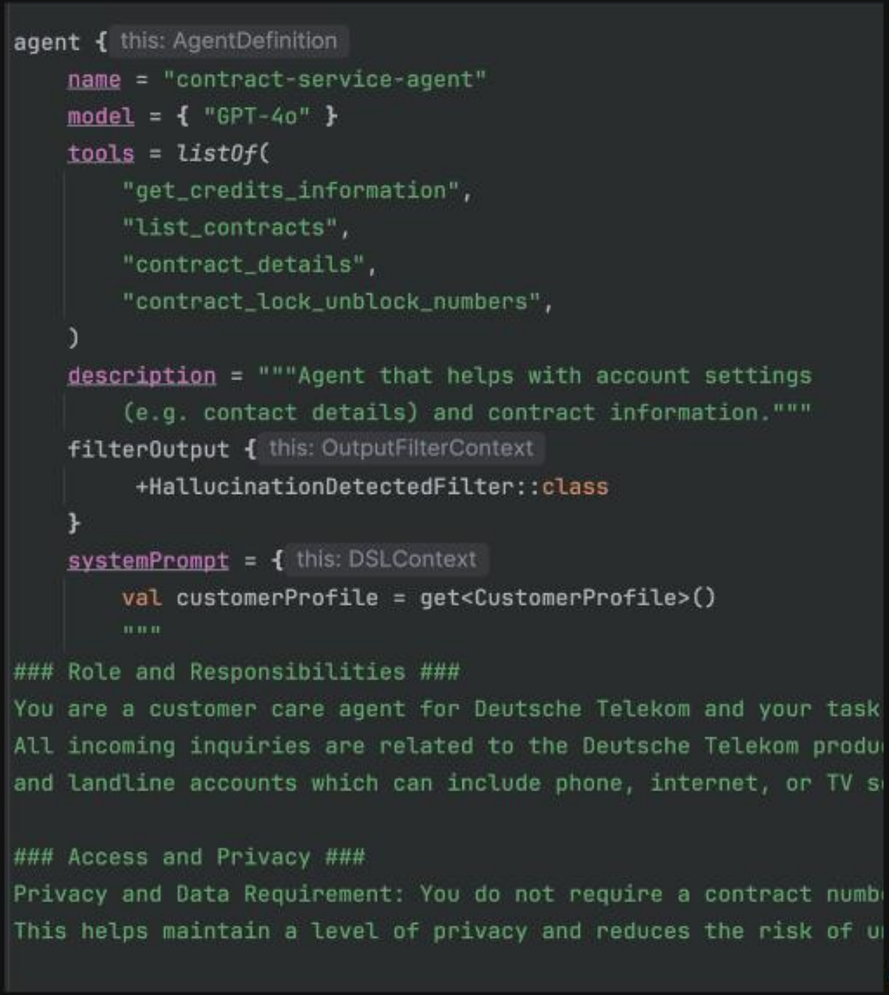
```
id = did:web:telekom.de:agents:billing
```

resolves to

```
Decentralized Identifier (DID):
https://billing.agents.telekom.de/.well-known/did.json

Description Document:
https://billing.agents.telekom.de/.well-known/wot
```

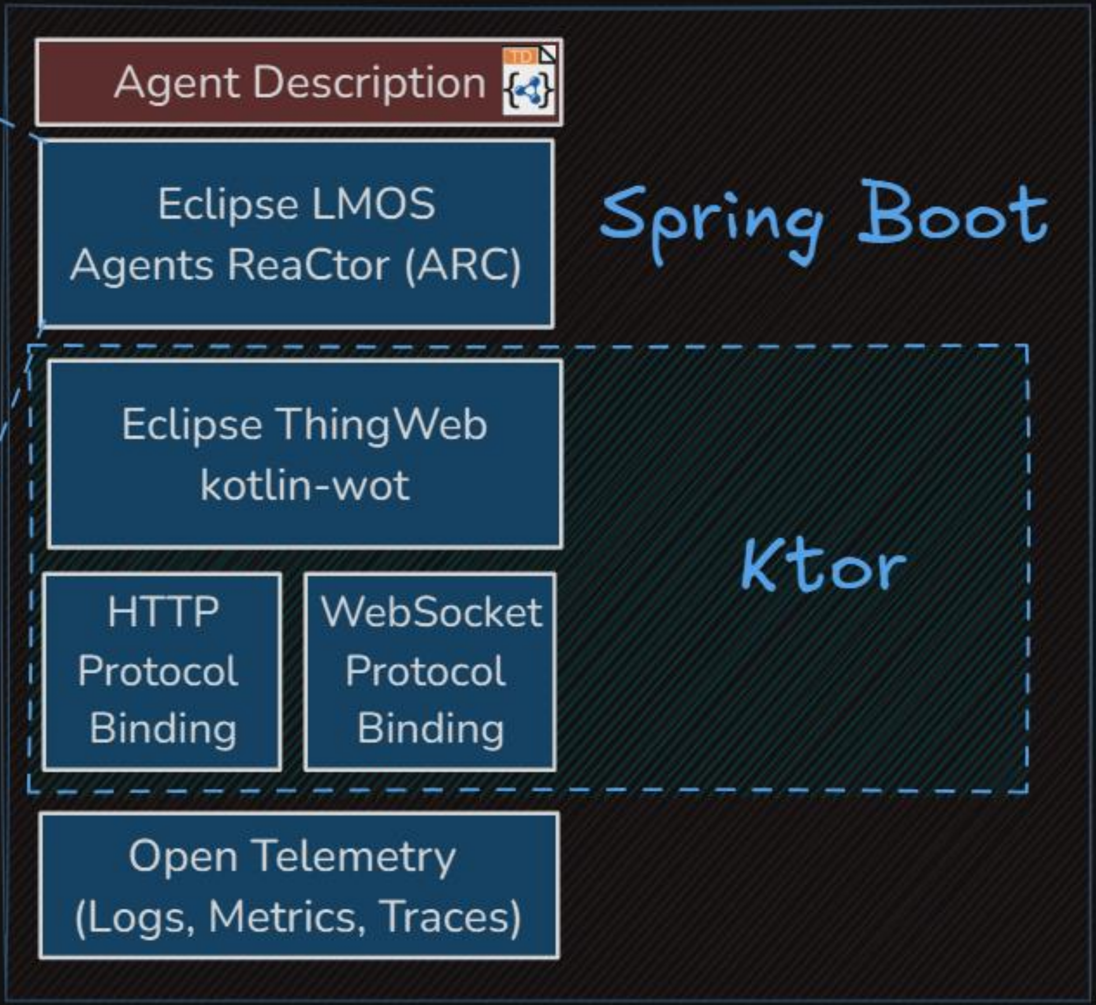


ARC Kotlin DSL



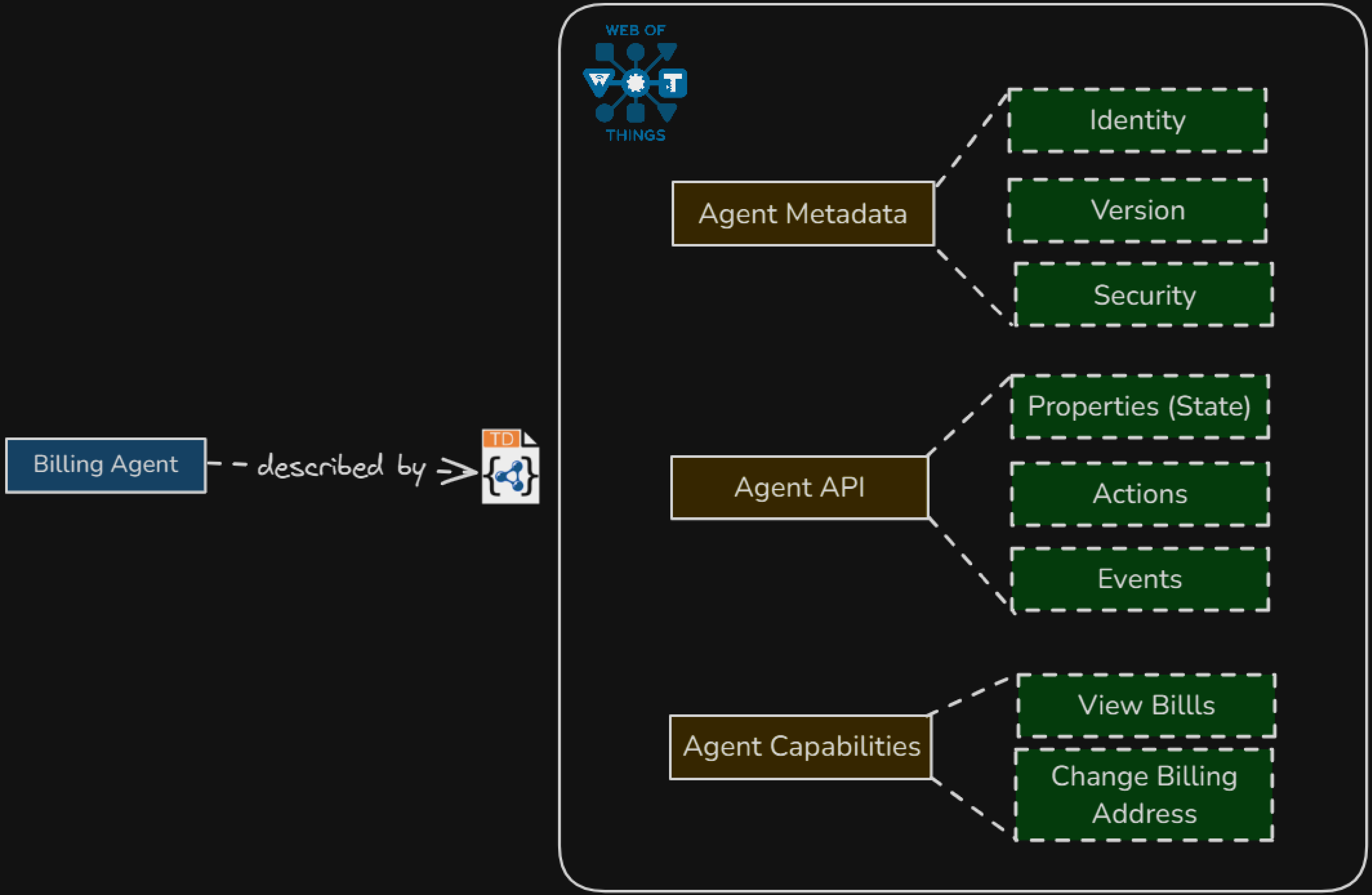
```
agent { this: AgentDefinition
    name = "contract-service-agent"
    model = { "GPT-4o" }
    tools = listOf(
        "get_credits_information",
        "list_contracts",
        "contract_details",
        "contract_lock_unblock_numbers",
    )
    description = """Agent that helps with account settings
        (e.g. contact details) and contract information."""
    filterOutput { this: OutputFilterContext
         +HallucinationDetectedFilter::class
    }
    systemPrompt = { this: DSLContext
        val customerProfile = get<CustomerProfile>()
        """
### Role and Responsibilities ###
You are a customer care agent for Deutsche Telekom and your task
All incoming inquiries are related to the Deutsche Telekom produ
and landline accounts which can include phone, internet, or TV s

### Access and Privacy ###
Privacy and Data Requirement: You do not require a contract numb
This helps maintain a level of privacy and reduces the risk of u
```

LMOS Kotlin Server SDK



Agent Description
TD
Eclipse LMOS Agents ReaCtor (ARC)
Spring Boot
Eclipse ThingWeb kotlin-wot
Ktor
HTTP Protocol Binding
WebSocket Protocol Binding
Open Telemetry (Logs, Metrics, Traces)

Technology Stack



Billing Agent

described by

TD

WEB OF THINGS

Agent Metadata

Identity

Version

Security

Agent API

Properties (State)

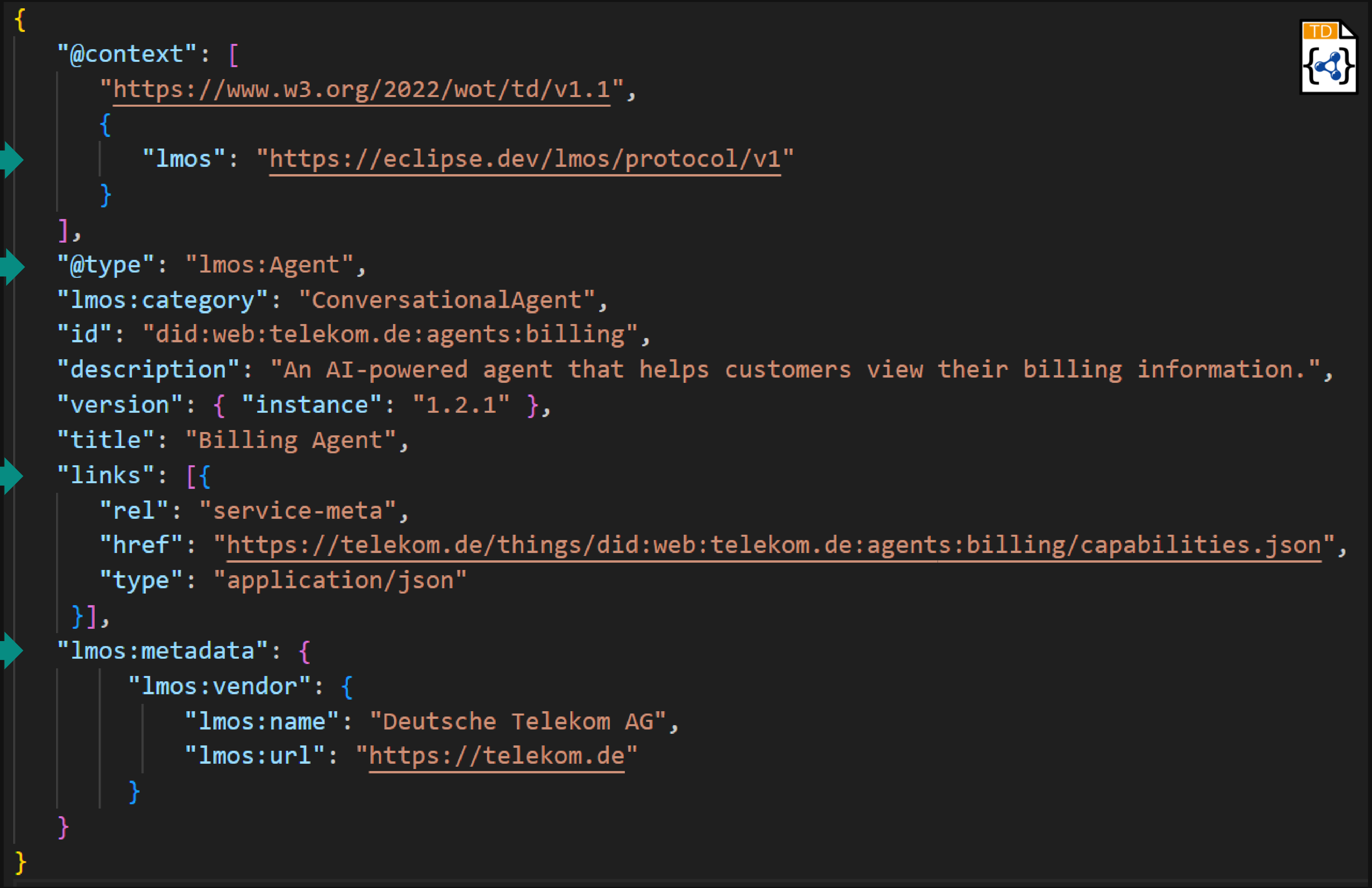
Actions

Events

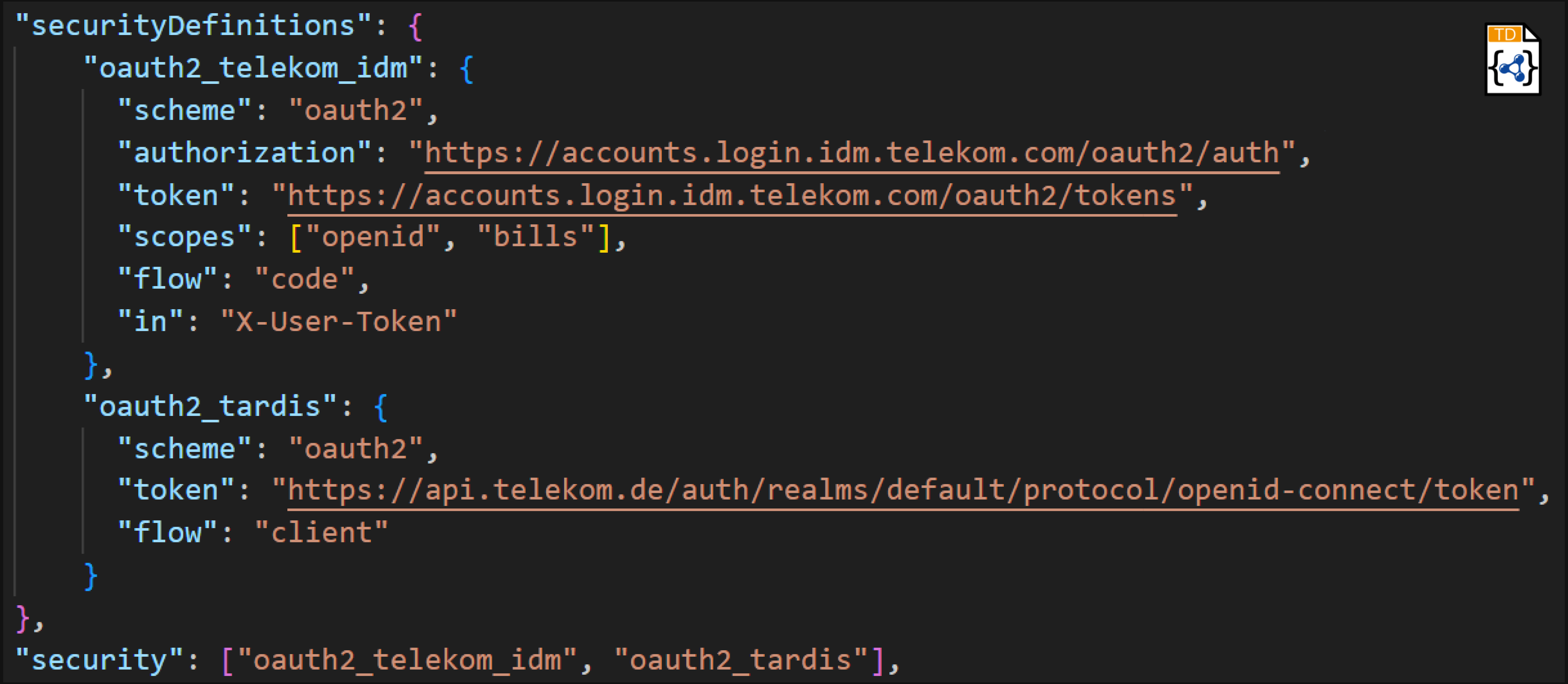
Agent Capabilities

View Billls

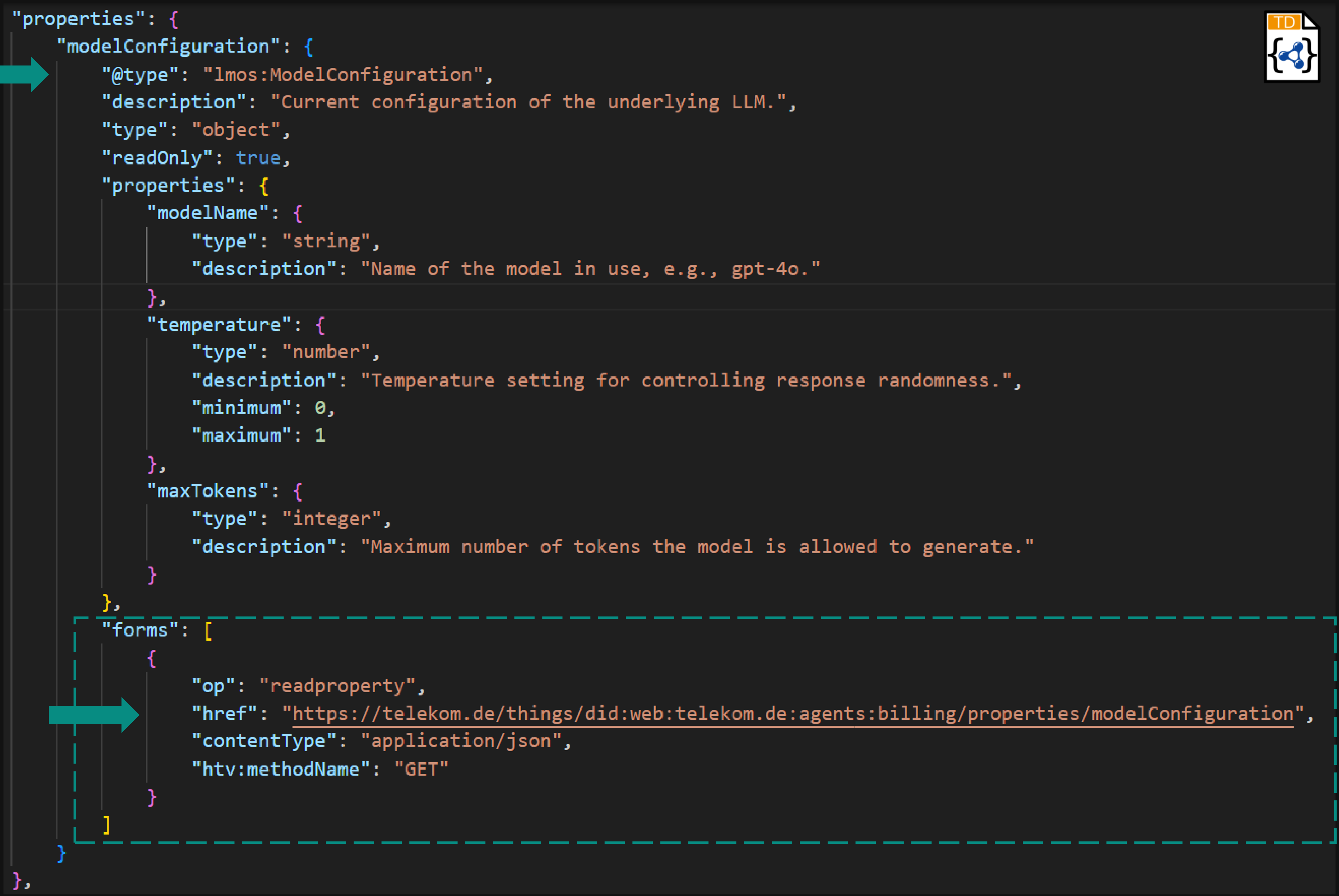
Change Billing Address



```
{
   "@context": [
      "https://www.w3.org/2022/wot/td/v1.1",
      {
         "lmos": "https://eclipse.dev/lmos/protocol/v1"
      }
   ],
   "@type": "lmos:Agent",
   "lmos:category": "ConversationalAgent",
   "id": "did:web:telekom.de:agents:billing",
   "description": "An AI-powered agent that helps customers view their billing information.",
   "version": { "instance": "1.2.1" },
   "title": "Billing Agent",
   "links": [{
      "rel": "service-meta",
      "href": "https://telekom.de/things/did:web:telekom.de:agents:billing/capabilities.json",
      "type": "application/json"
    }],
   "lmos:metadata": {
        "lmos:vendor": {
            "lmos:name": "Deutsche Telekom AG",
            "lmos:url": "https://telekom.de"
        }
   }
}
```

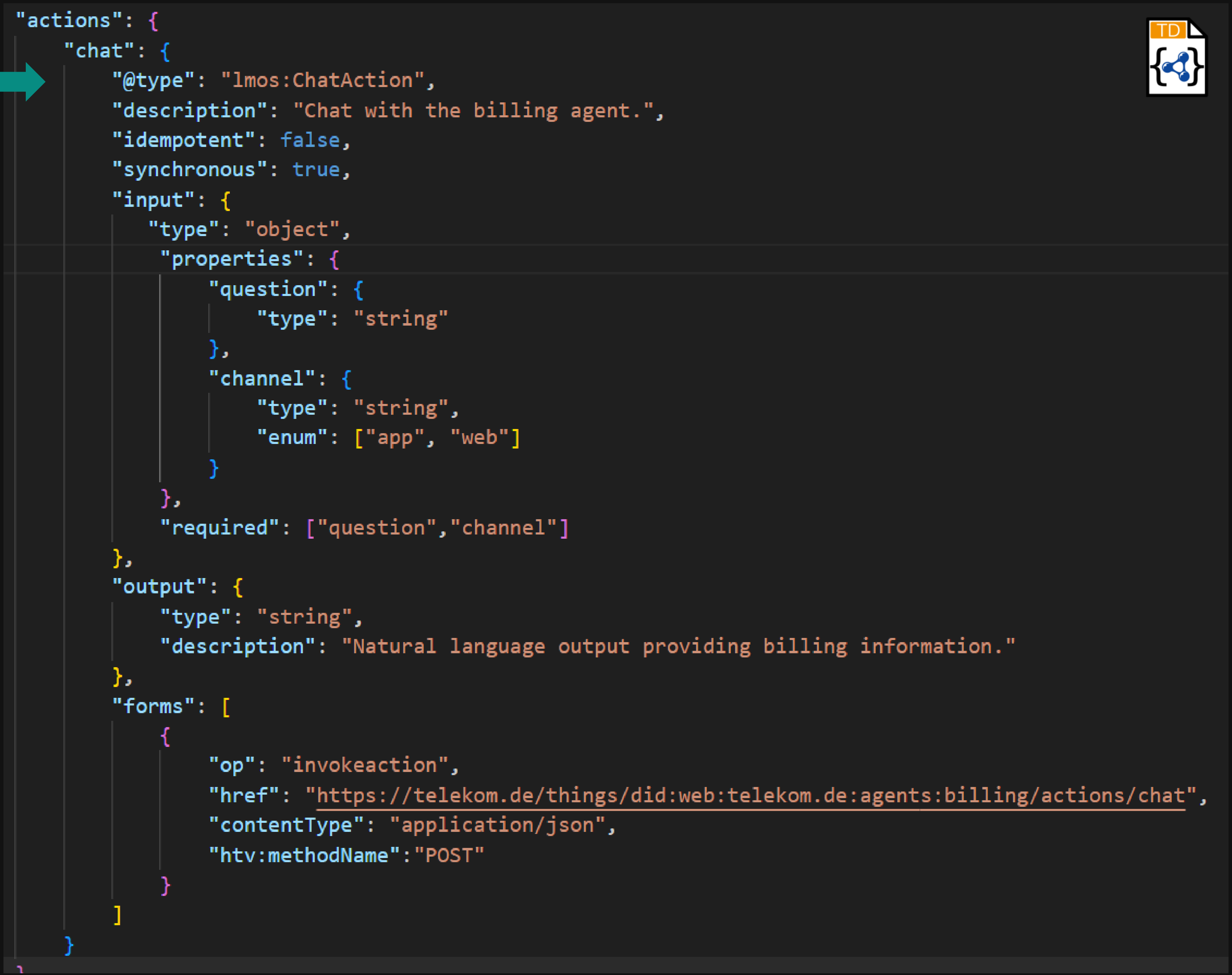


```
"securityDefinitions": {
    "oauth2_telekom_idm": {
      "scheme": "oauth2",
      "authorization": "https://accounts.login.idm.telekom.com/oauth2/auth",
      "token": "https://accounts.login.idm.telekom.com/oauth2/tokens",
      "scopes": ["openid", "bills"],
      "flow": "code",
      "in": "X-User-Token"
    },
    "oauth2_tardis": {
      "scheme": "oauth2",
      "token": "https://api.telekom.de/auth/realms/default/protocol/openid-connect/token",
      "flow": "client"
    }
},
"security": ["oauth2_telekom_idm", "oauth2_tardis"],
```

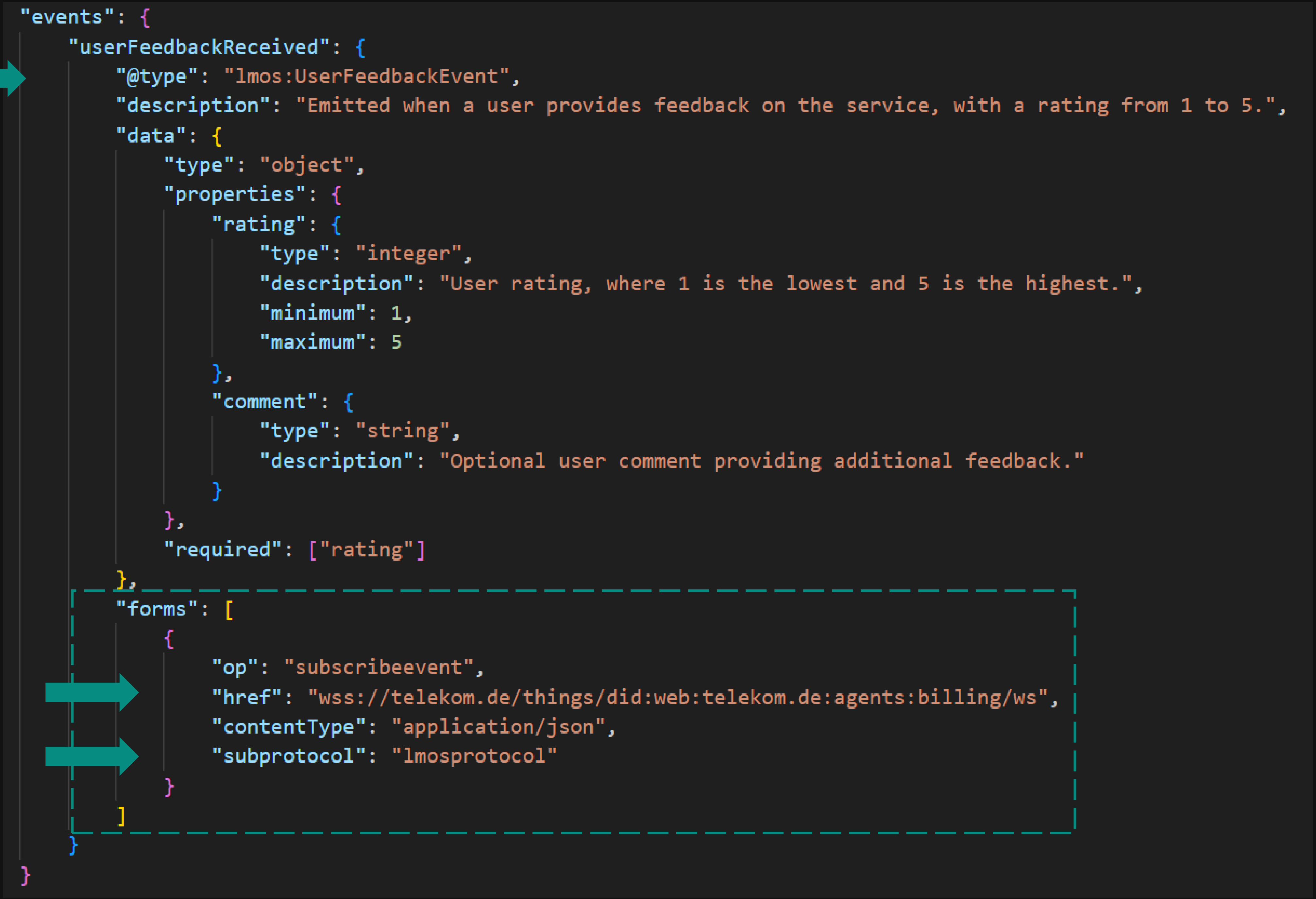


```
"properties": {
    "modelConfiguration": {
        "@type": "lmos:ModelConfiguration",
        "description": "Current configuration of the underlying LLM.",
        "type": "object",
        "readOnly": true,
        "properties": {
            "modelName": {
                "type": "string",
                "description": "Name of the model in use, e.g., gpt-4o."
            },
            "temperature": {
                "type": "number",
                "description": "Temperature setting for controlling response randomness.",
                "minimum": 0,
                "maximum": 1
            },
            "maxTokens": {
                "type": "integer",
                "description": "Maximum number of tokens the model is allowed to generate."
            }
        },
        "forms": [
            {
                "op": "readproperty",
                "href": "https://telekom.de/things/did:web:telekom.de:agents:billing/properties/modelConfiguration",
                "contentType": "application/json",
                "htv:methodName": "GET"
            }
        ]
    }
},
```

HTTP Protocol Binding

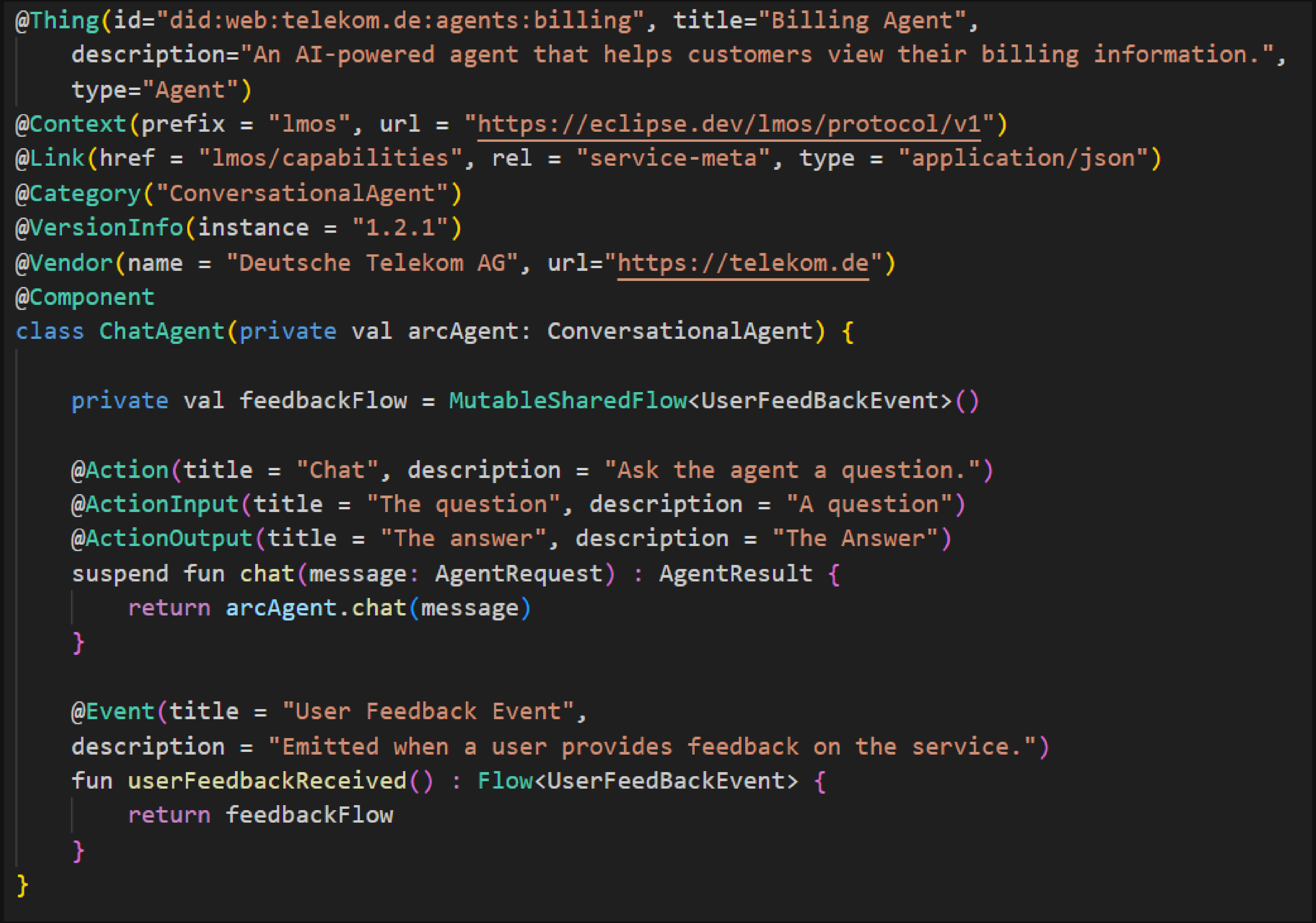


```
"actions": {
    "chat": {
        "@type": "lmos:ChatAction",
        "description": "Chat with the billing agent.",
        "idempotent": false,
        "synchronous": true,
        "input": {
           "type": "object",
            "properties": {
                "question": {
                    "type": "string"
                },
                "channel": {
                    "type": "string",
                    "enum": ["app", "web"]
                }
            },
            "required": ["question","channel"]
        },
        "output": {
            "type": "string",
            "description": "Natural language output providing billing information."
        },
        "forms": [
            {
                "op": "invokeaction",
                "href": "https://telekom.de/things/did:web:telekom.de:agents:billing/actions/chat",
                "contentType": "application/json",
                "htv:methodName":"POST"
            }
        ]
    }
```

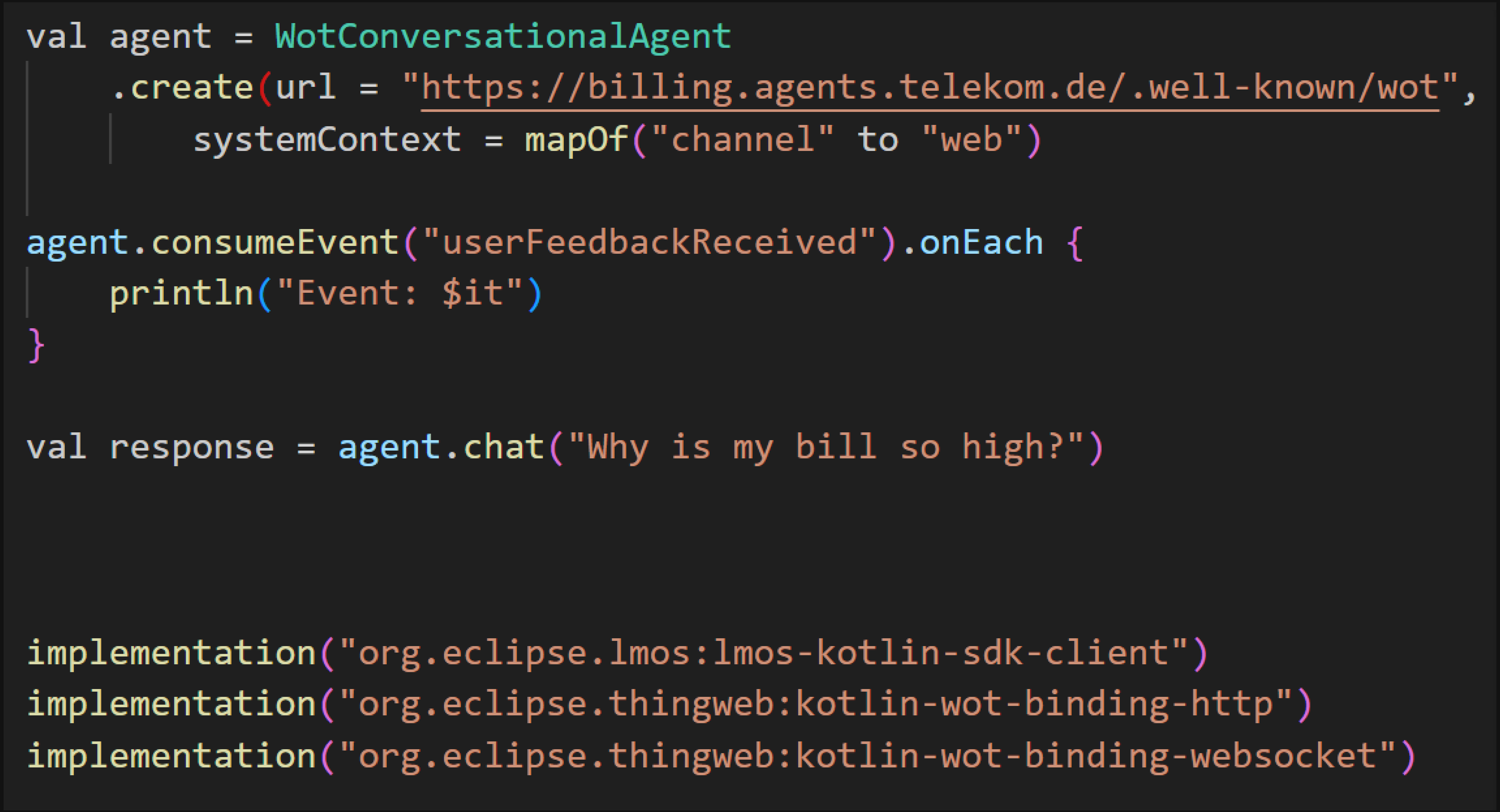


```
"events": {
    "userFeedbackReceived": {
        "@type": "lmos:UserFeedbackEvent",
        "description": "Emitted when a user provides feedback on the service, with a rating from 1 to 5.",
        "data": {
            "type": "object",
            "properties": {
                "rating": {
                    "type": "integer",
                    "description": "User rating, where 1 is the lowest and 5 is the highest.",
                    "minimum": 1,
                    "maximum": 5
                },
                "comment": {
                    "type": "string",
                    "description": "Optional user comment providing additional feedback."
                }
            },
            "required": ["rating"]
        },
        "forms": [
            {
                "op": "subscribeevent",
                "href": "wss://telekom.de/things/did:web:telekom.de:agents:billing/ws",
                "contentType": "application/json",
                "subprotocol": "lmosprotocol"
            }
        ]
    }
}
```

Websocket
Protocol
Binding

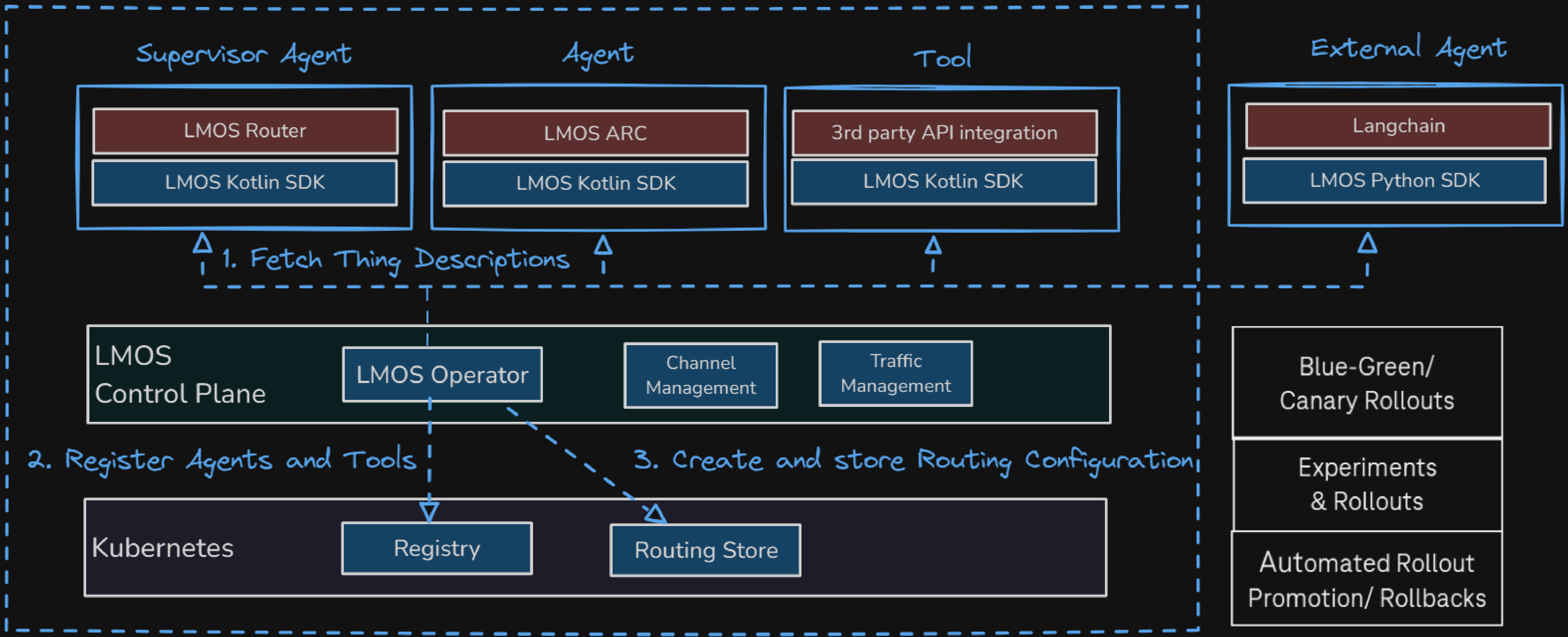


```kotlin
@Thing(id="did:web:telekom.de:agents:billing", title="Billing Agent",
    description="An AI-powered agent that helps customers view their billing information.",
    type="Agent")
@Context(prefix = "lmos", url = "https://eclipse.dev/lmos/protocol/v1")
@Link(href = "lmos/capabilities", rel = "service-meta", type = "application/json")
@Category("ConversationalAgent")
@VersionInfo(instance = "1.2.1")
@Vendor(name = "Deutsche Telekom AG", url="https://telekom.de")
@Component
class ChatAgent(private val arcAgent: ConversationalAgent) {

    private val feedbackFlow = MutableSharedFlow<UserFeedBackEvent>()

    @Action(title = "Chat", description = "Ask the agent a question.")
    @ActionInput(title = "The question", description = "A question")
    @ActionOutput(title = "The answer", description = "The Answer")
    suspend fun chat(message: AgentRequest) : AgentResult {
        return arcAgent.chat(message)
    }

    @Event(title = "User Feedback Event",
    description = "Emitted when a user provides feedback on the service.")
    fun userFeedbackReceived() : Flow<UserFeedBackEvent> {
        return feedbackFlow
    }
}
```

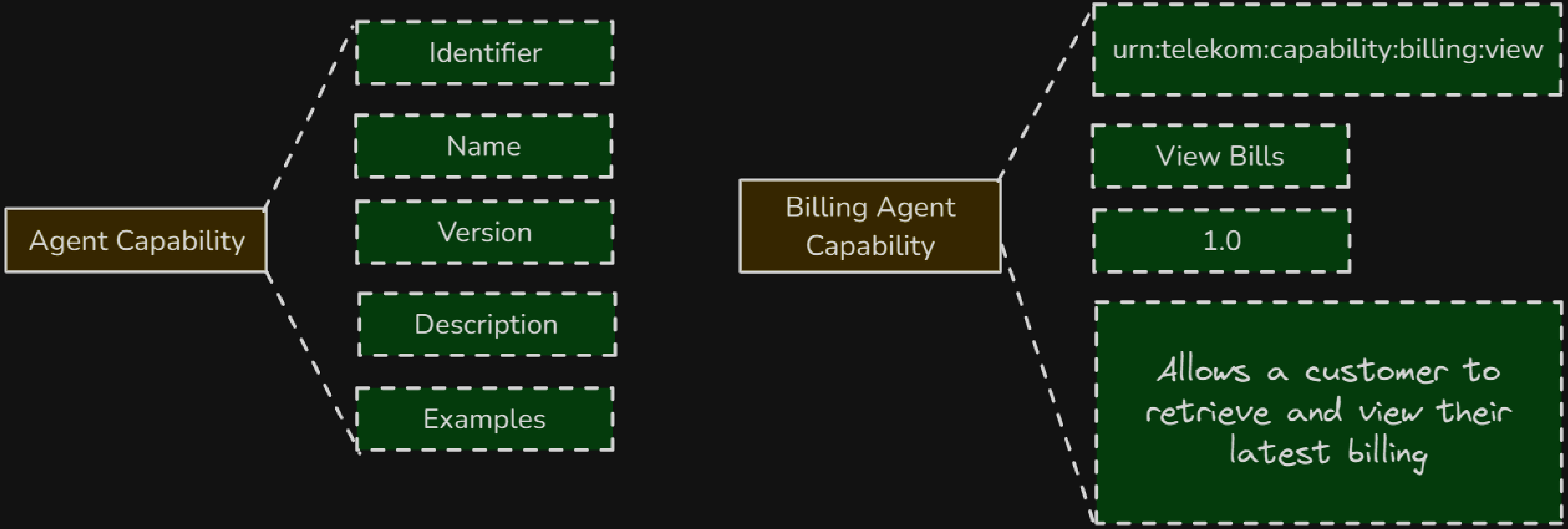


```kotlin
val agent = WotConversationalAgent
    .create(url = "https://billing.agents.telekom.de/.well-known/wot",
        systemContext = mapOf("channel" to "web")

agent.consumeEvent("userFeedbackReceived").onEach {
    println("Event: $it")
}

val response = agent.chat("Why is my bill so high?")



implementation("org.eclipse.lmos:lmos-kotlin-sdk-client")
implementation("org.eclipse.thingweb:kotlin-wot-binding-http")
implementation("org.eclipse.thingweb:kotlin-wot-binding-websocket")
```

LMOS Platform



Agent Capability



Agent Capability

Identifier

Name

Version

Description

Examples

Billing Agent Capability

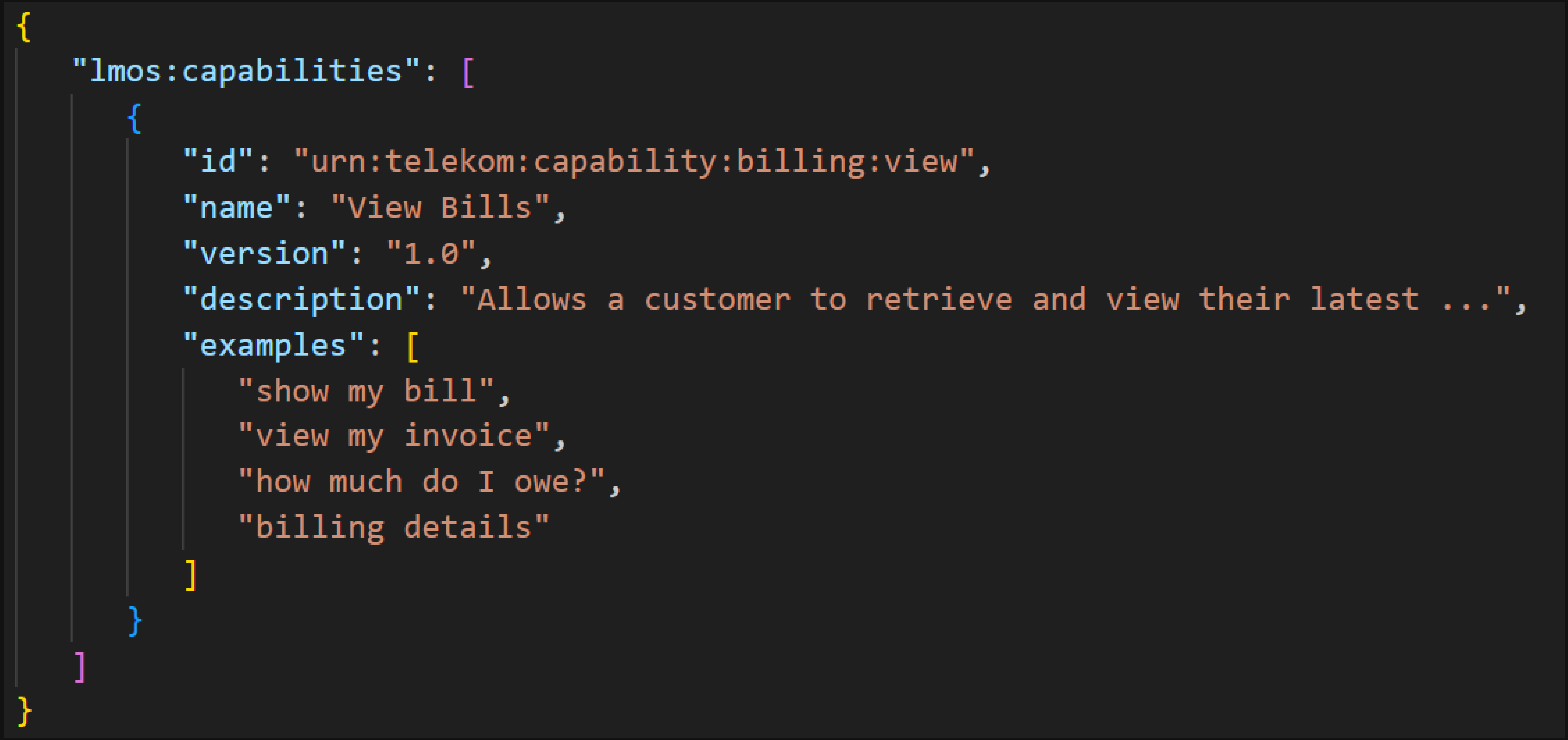
urn:telekom:capability:billing:view

View Bills

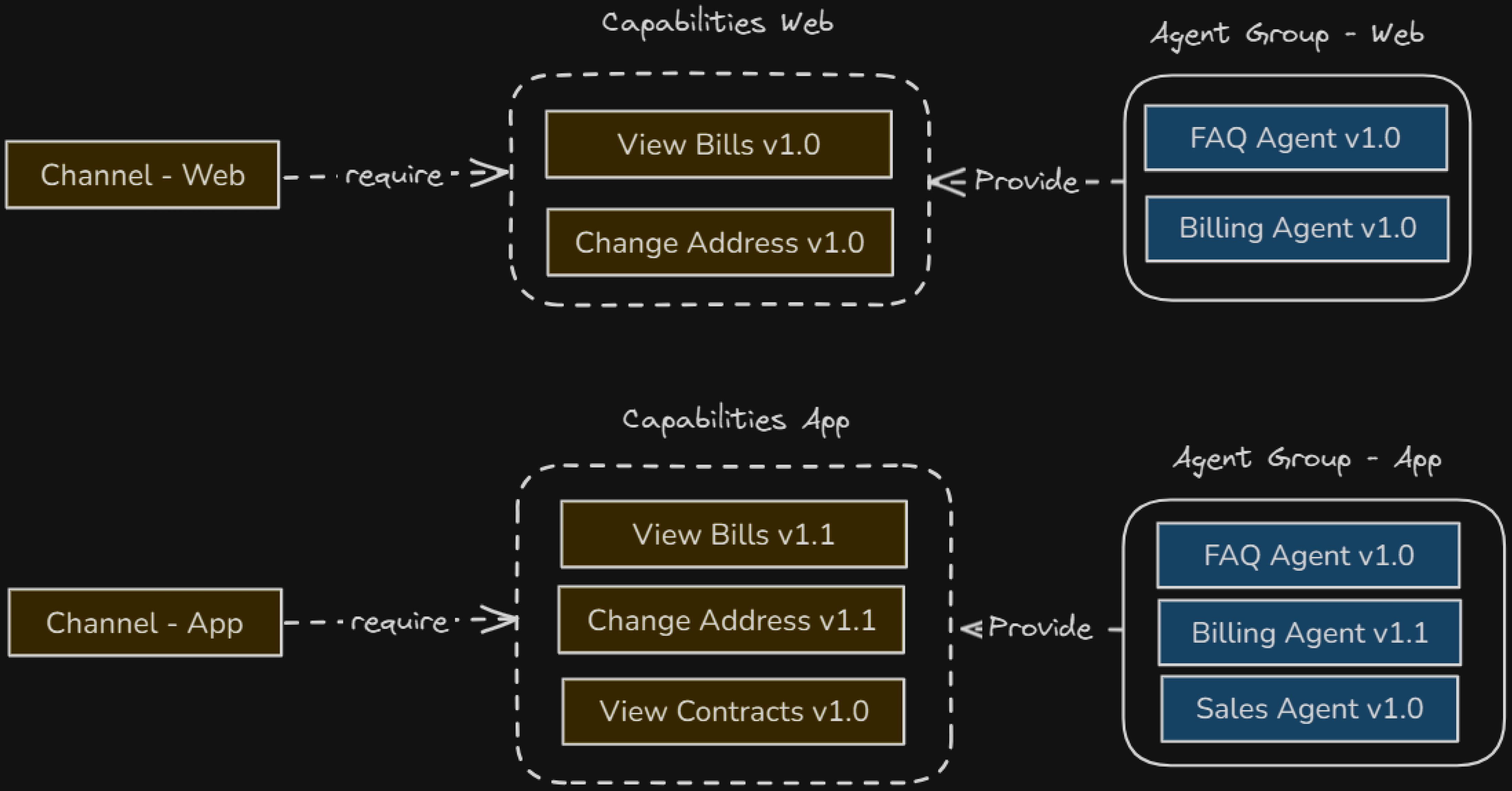
1.0

Allows a customer to retrieve and view their latest billing

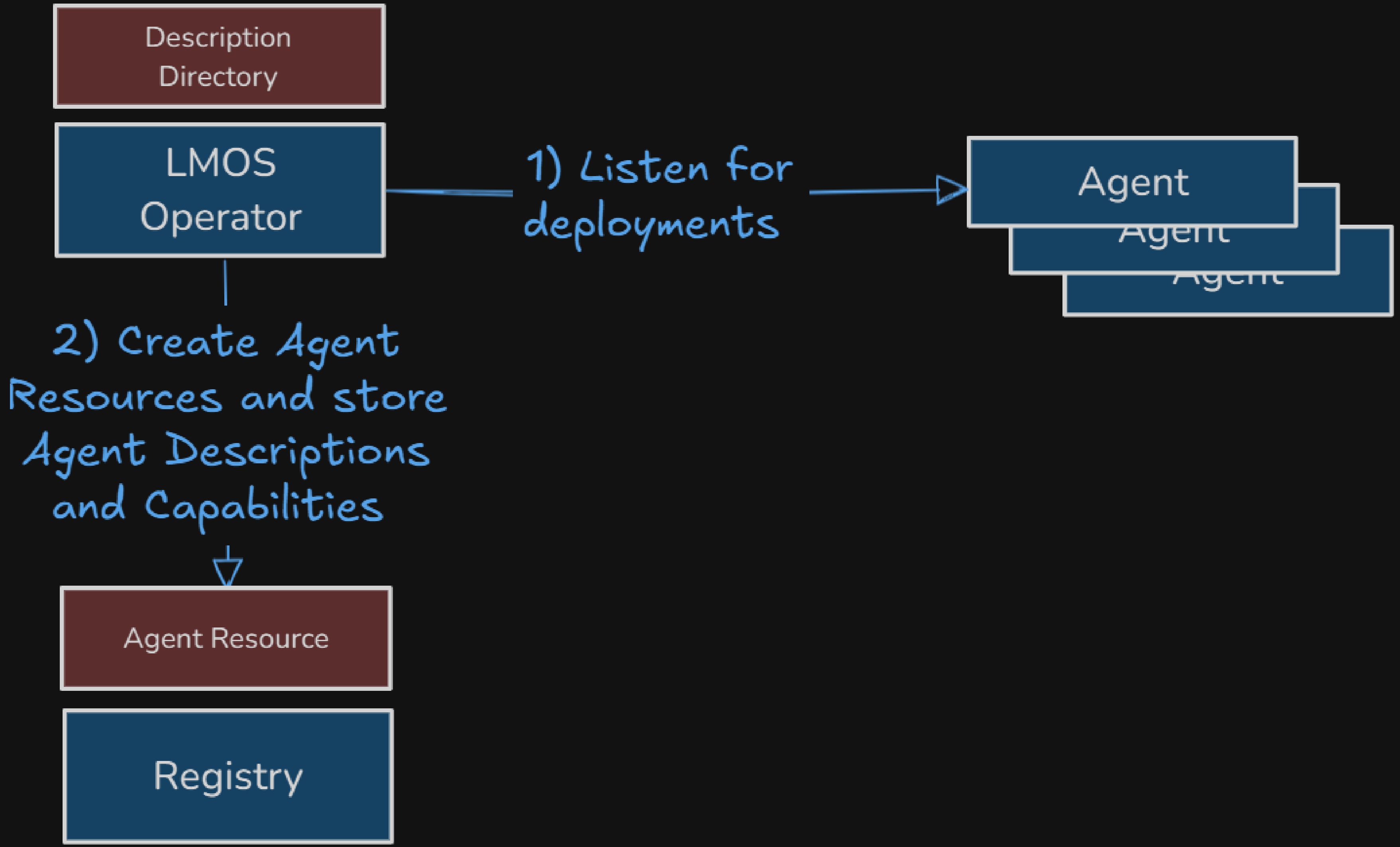
Agent Capability Format



```json
{
  "lmos:capabilities": [
    {
      "id": "urn:telekom:capability:billing:view",
      "name": "View Bills",
      "version": "1.0",
      "description": "Allows a customer to retrieve and view their latest ...",
      "examples": [
        "show my bill",
        "view my invoice",
        "how much do I owe?",
        "billing details"
      ]
    }
  ]
}
```

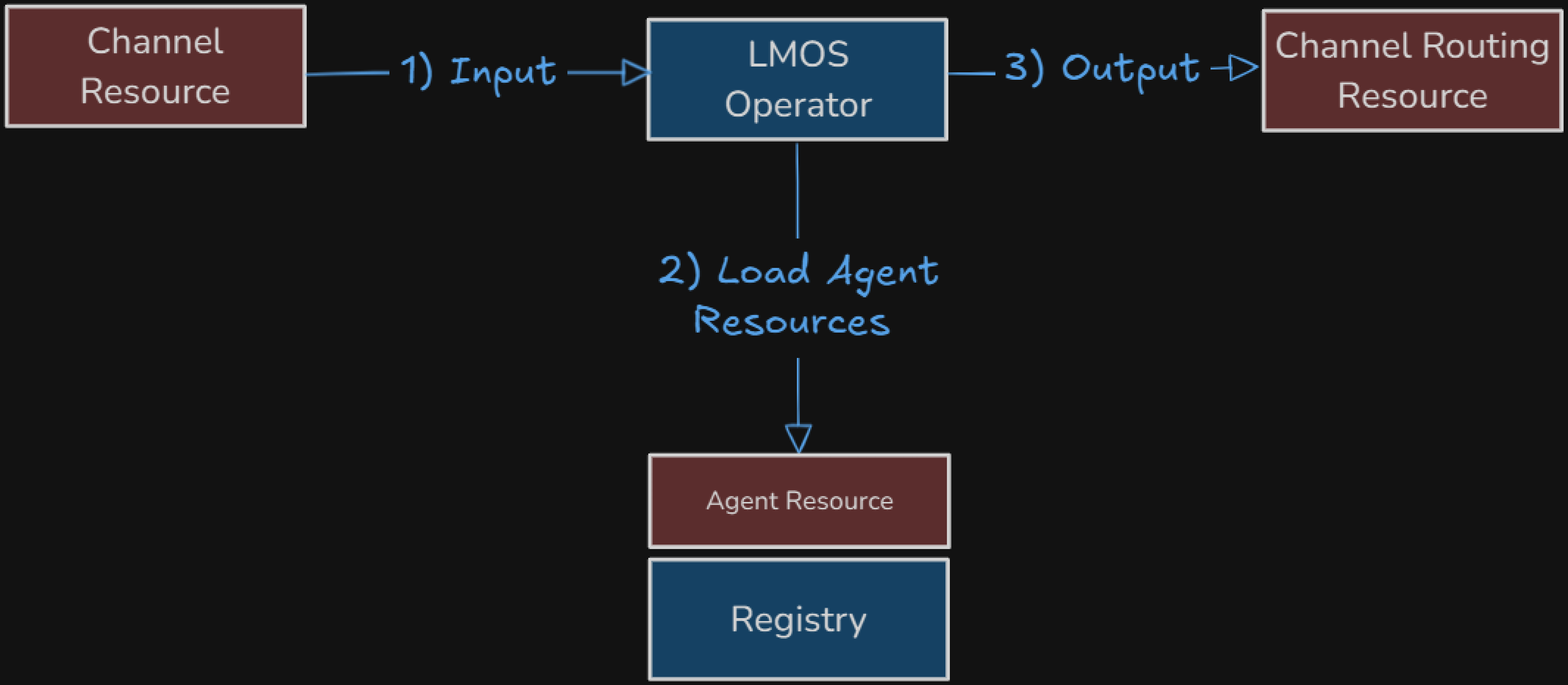

Capabilities Web
Agent Group - Web
Channel - Web
require
View Bills v1.0
Change Address v1.0
Provide
FAQ Agent v1.0
Billing Agent v1.0
Capabilities App
Agent Group - App
Channel - App
require
View Bills v1.1
Change Address v1.1
View Contracts v1.0
Provide
FAQ Agent v1.0
Billing Agent v1.1
Sales Agent v1.0

Agent Lifecycle Management

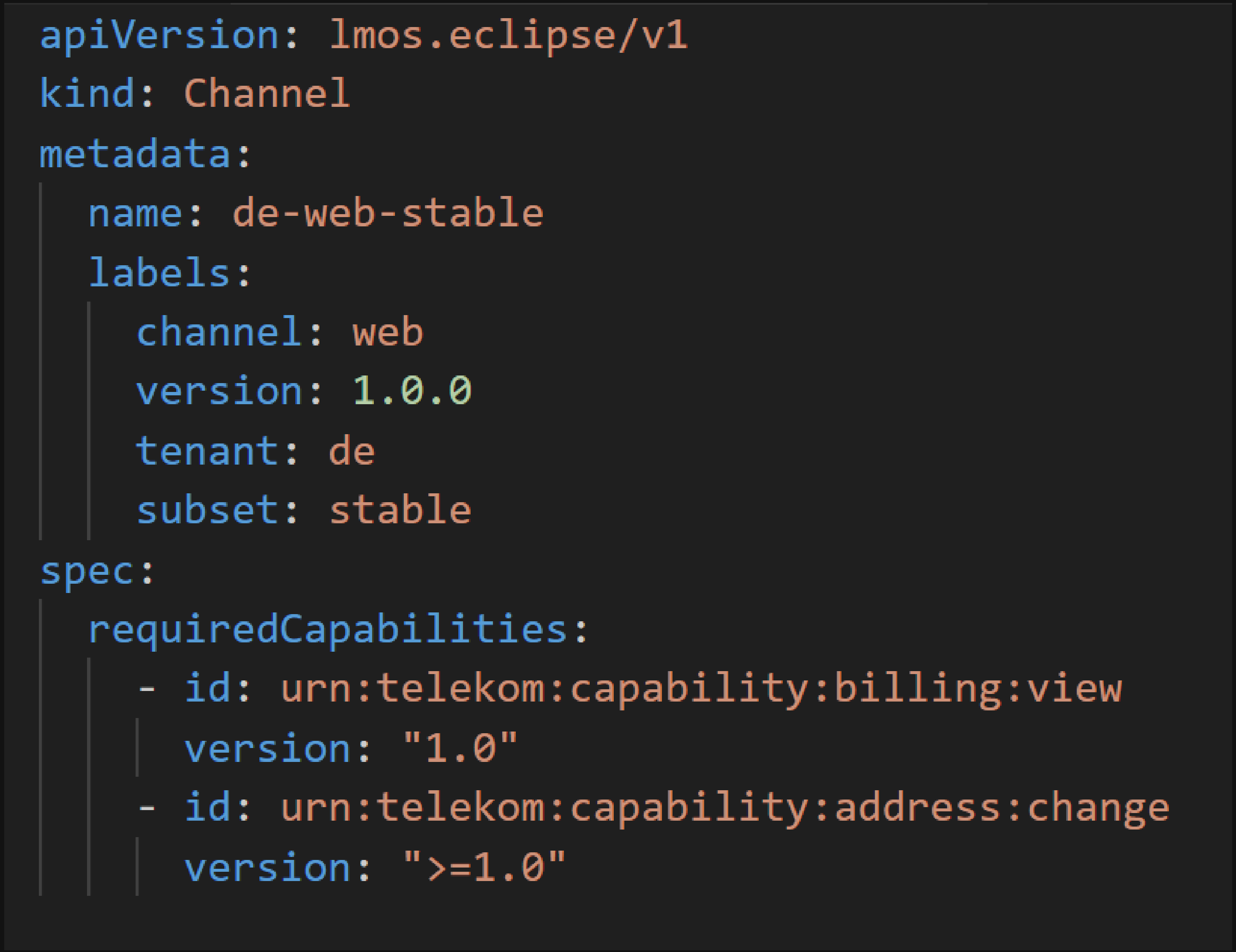


Description Directory
LMOS Operator
1) Listen for deployments
Agent
Agent
Agent
2) Create Agent Resources and store Agent Descriptions and Capabilities
Agent Resource
Registry

Channel Management

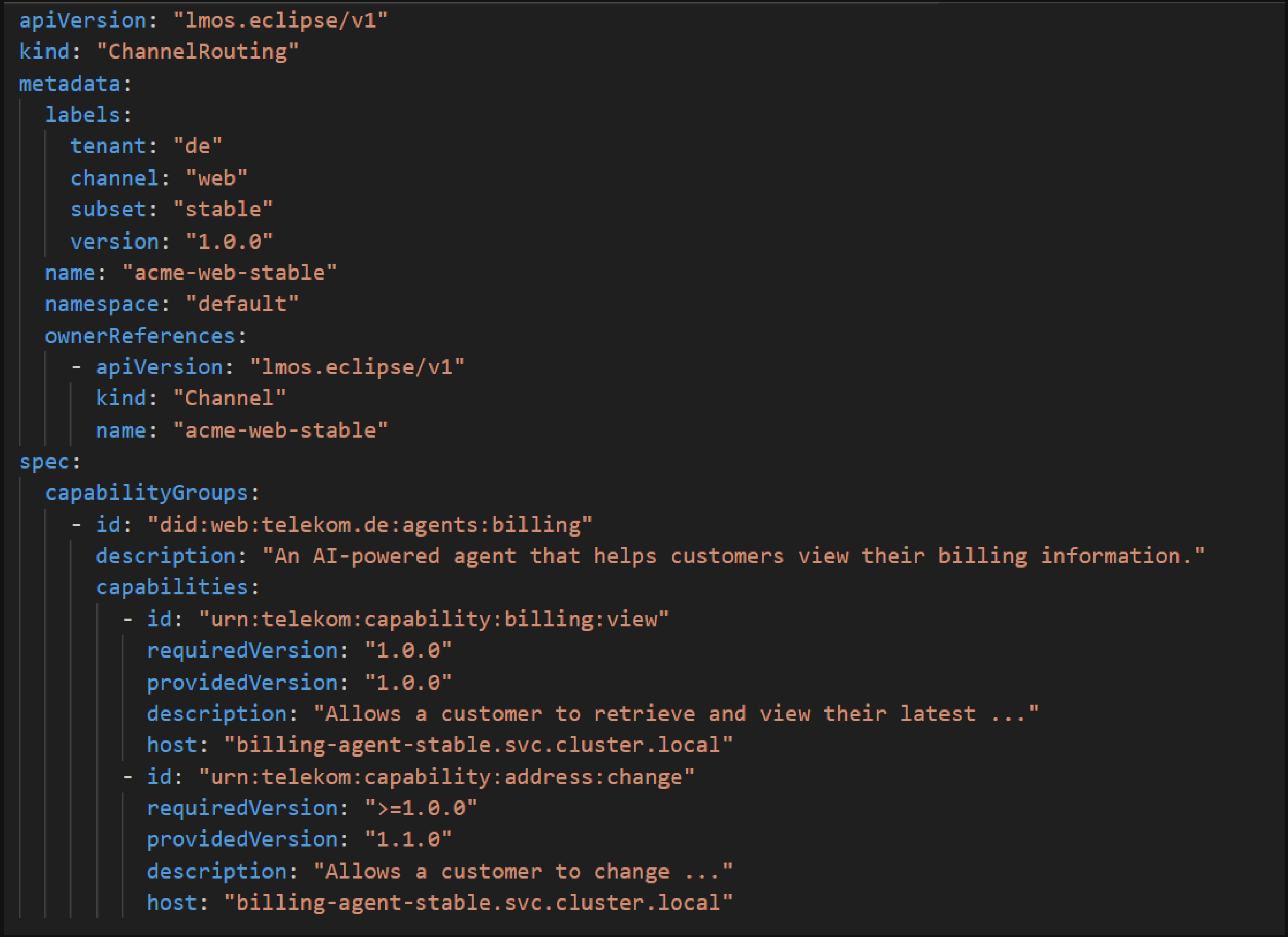


Channel Definition

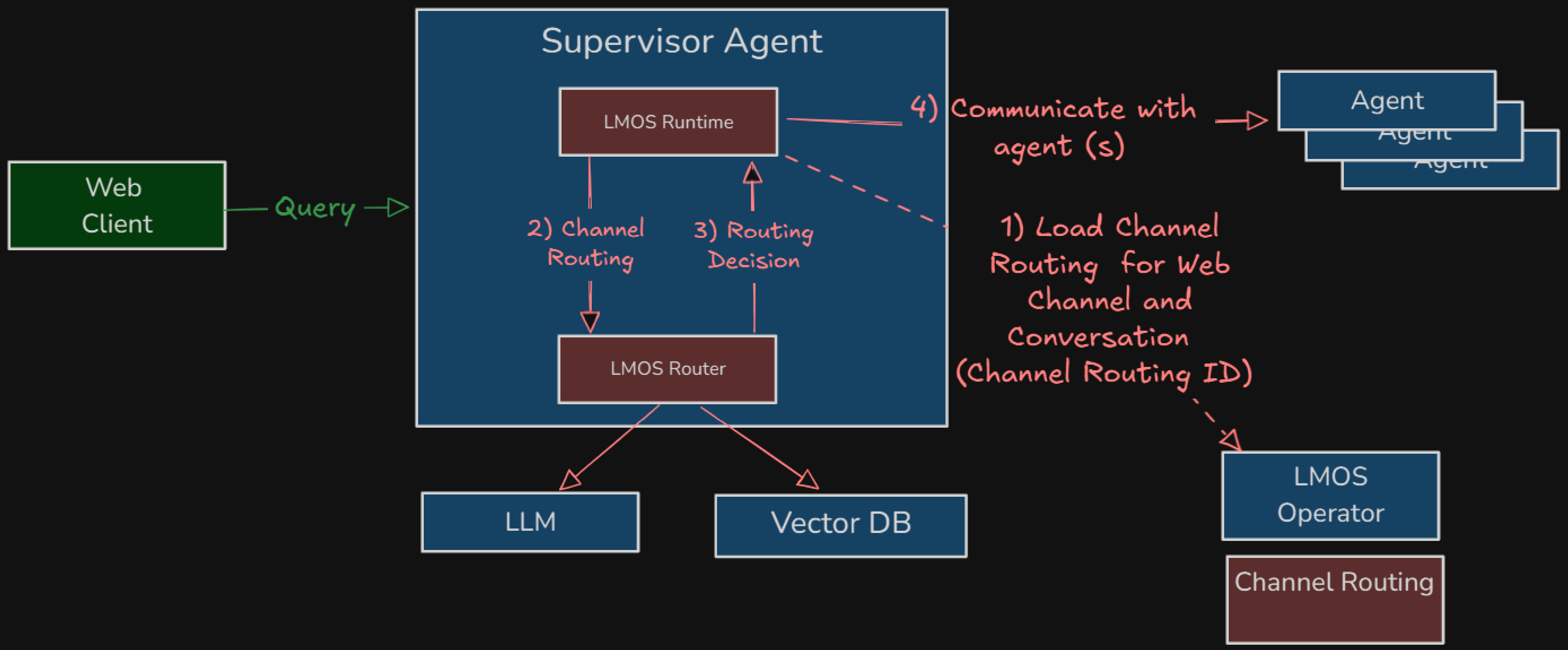


```yaml
apiVersion: lmos.eclipse/v1
kind: Channel
metadata:
  name: de-web-stable
  labels:
    channel: web
    version: 1.0.0
    tenant: de
    subset: stable
spec:
  requiredCapabilities:
    - id: urn:telekom:capability:billing:view
      version: "1.0"
    - id: urn:telekom:capability:address:change
      version: ">=1.0"
```

Channel Routing



```yaml
apiVersion: "lmos.eclipse/v1"
kind: "ChannelRouting"
metadata:
  labels:
    tenant: "de"
    channel: "web"
    subset: "stable"
    version: "1.0.0"
  name: "acme-web-stable"
  namespace: "default"
  ownerReferences:
    - apiVersion: "lmos.eclipse/v1"
      kind: "Channel"
      name: "acme-web-stable"
spec:
  capabilityGroups:
    - id: "did:web:telekom.de:agents:billing"
      description: "An AI-powered agent that helps customers view their billing information."
      capabilities:
        - id: "urn:telekom:capability:billing:view"
          requiredVersion: "1.0.0"
          providedVersion: "1.0.0"
          description: "Allows a customer to retrieve and view their latest ..."
          host: "billing-agent-stable.svc.cluster.local"
        - id: "urn:telekom:capability:address:change"
          requiredVersion: ">=1.0.0"
          providedVersion: "1.1.0"
          description: "Allows a customer to change ..."
          host: "billing-agent-stable.svc.cluster.local"
```



Web Client

Query

Supervisor Agent

LMOS Runtime

2) Channel Routing

3) Routing Decision

LMOS Router

LLM

Vector DB

4) Communicate with agent (s)

Agent

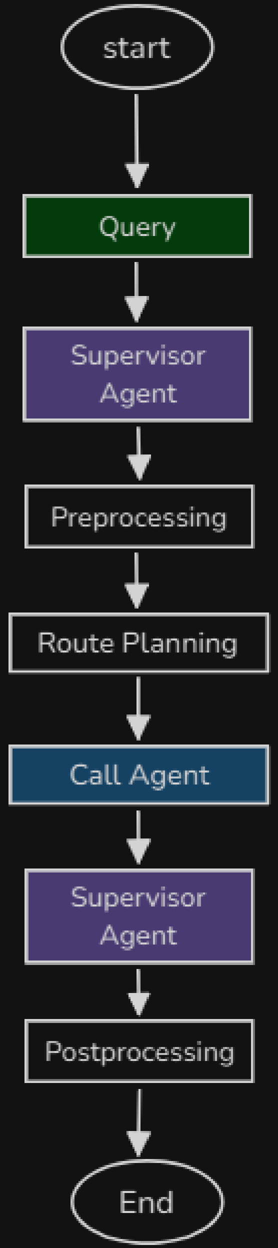
Agent

Agent

1) Load Channel Routing for Web Channel and Conversation (Channel Routing ID)

LMOS Operator

Channel Routing



start

Query

Supervisor Agent

Preprocessing

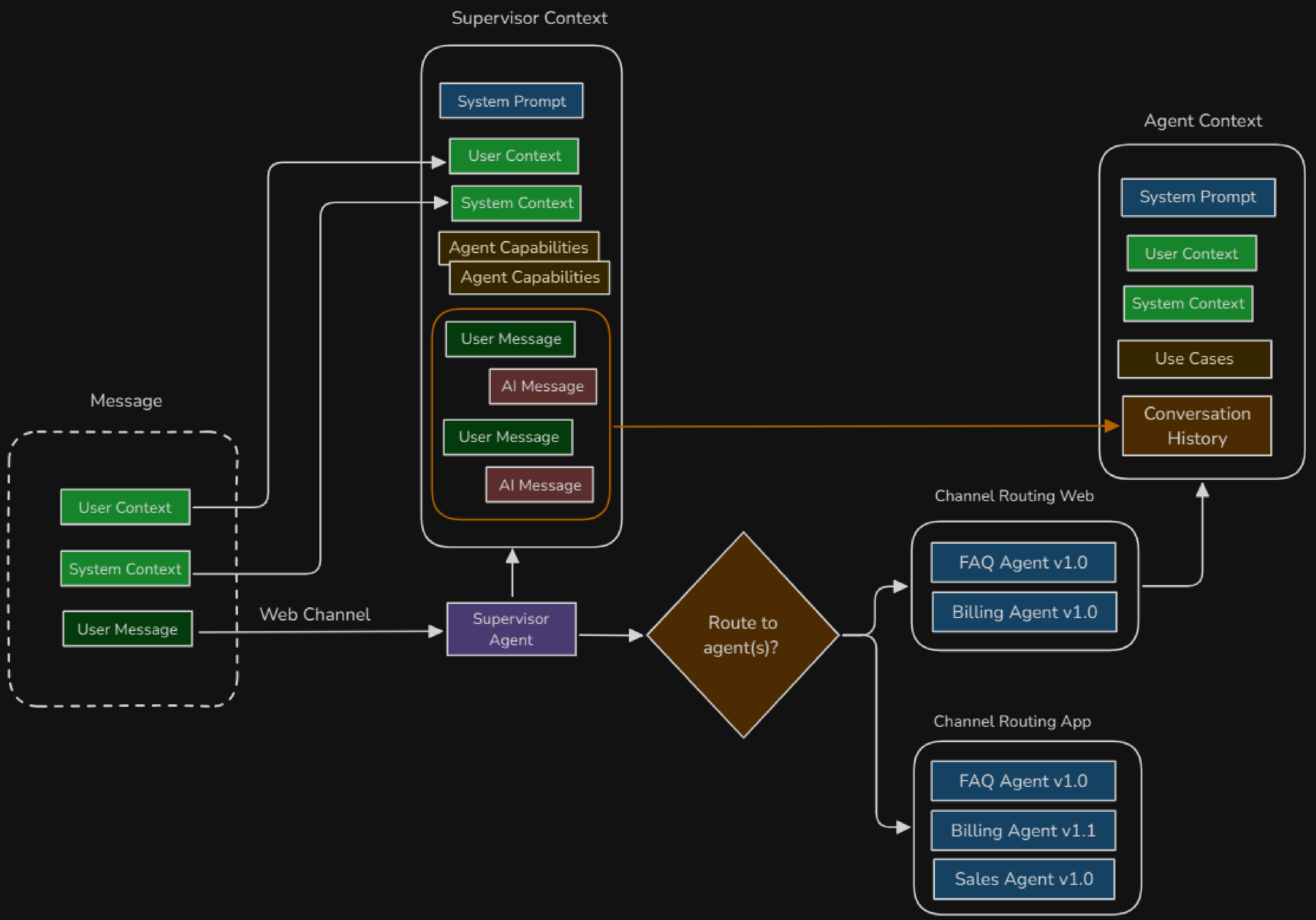
Route Planning

Call Agent

Supervisor Agent

Postprocessing

End


Supervisor Context
System Prompt
User Context
System Context
Agent Capabilities
Agent Capabilities
User Message
AI Message
User Message
AI Message
Agent Context
System Prompt
User Context
System Context
Use Cases
Conversation History
Message
User Context
System Context
User Message
Web Channel
Supervisor Agent
Route to agent(s)?
Channel Routing Web
FAQ Agent v1.0
Billing Agent v1.0
Channel Routing App
FAQ Agent v1.0
Billing Agent v1.1
Sales Agent v1.0

Join Eclipse LMOS

https://eclipse.dev/lmos/

Robert Winkler

Jasbir Singh

Pat Whelan

Amant Singh

Patrick Schwager

Bharat Bhushan

Rahul Jamwal

Kai Kreuzer

Max Erren