Anypoint Platform Architecture: Application Networks

Module 5
Enforcing NFRs on the Level of API Invocations Using Anypoint API Manager

Objectives

- Describe how **API Manager** controls API invocations
- Use **API policies** to enforce non-functional constraints on API invocations
- Choose between **enforcement of API policies** in an API implementation and an **API proxy**
- Register an **API client** for access to an API version
- Describe when and how to pass **client ID/secret** to an API
- Establish **guidelines for API policies** suitable for System APIs, Process APIs, and Experience APIs

Addressing the NFRs of the "Aggregator Integration" product

NFRs for "Create quote for aggregators"

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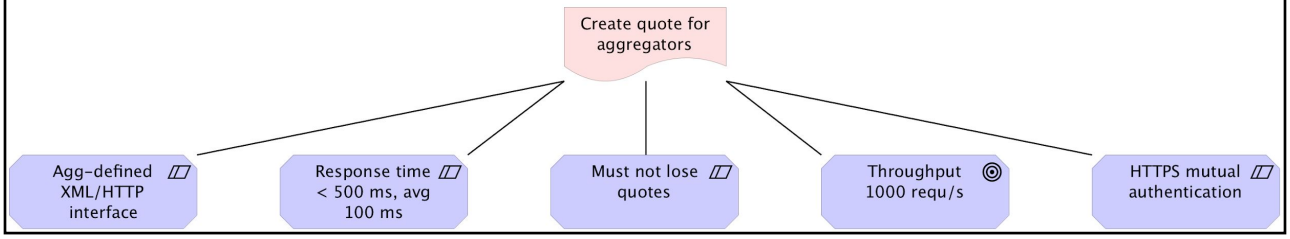
- Synchronous creation of up to **5 quotes**:
  - Aggregator-defined **XML**-formatted policy description in HTTP POST request
  - **Up to 5 quotes** in Aggregator-defined XML format in HTTP response
- **Performance**:
  - Throughput: up to **1000 requs/s**
  - Response time: median = **200 ms**, maximum = **500 ms** at 1000 requs/s
- **Security**: **HTTPS mutual authentication**
- **Reliability**: quotes are legally binding and **must not be lost**



Meeting NFRs for "Create quote for aggregators" using Anypoint Platform

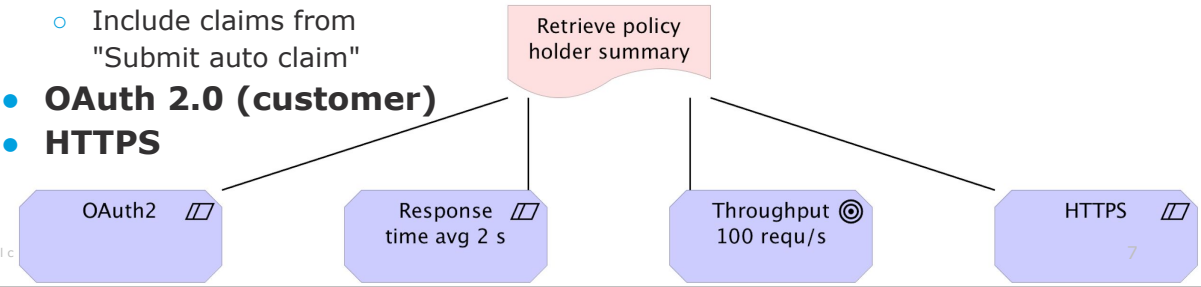
MuleSoft

- **Throughput and response time**:
  - Must be broken-down to APIs in **all tiers**
  - Must be **enforced, monitored and analyzed**
    - API Manager, Anypoint Analytics
  - Anticipate **caching**
  - Highly **performant** runtime plane for API implementations: **CloudHub**
  - Need to carefully manage **load on Policy Admin System**: API Manager
- Must not lose quotes:
  - Synchronous invocations incl. ACID operation on **Policy Admin System**
- HTTPS mutual authentication:
  - **CloudHub Dedicated Load Balancer**
- Should add **client authentication** on top of HTTPS mutual auth

Addressing the NFRs of the "Customer Self-Service App" product

NFRs for "Retrieve policy holder summary"

- Part of "Customer Self-Service App" product
  - Might be opened-up to **external API consumers**
- **Synchronous** HTTP request-response chain
- **Performance**:
  - Ill-defined, aim for **100 requs/s**
  - Aim for avg response time of **2 s** at 100 requs/s
- **Consistency**:
  - Include claims from "Submit auto claim"
- **OAuth 2.0 (customer)**
- **HTTPS**

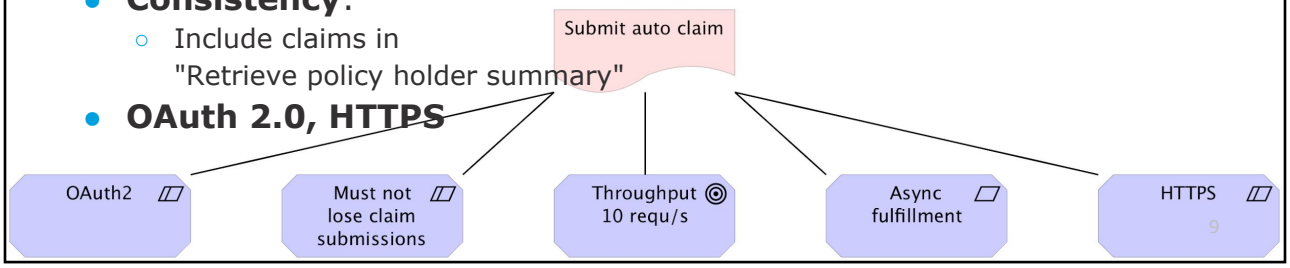


Meeting the NFRs for "Retrieve policy holder summary" using Anypoint Platform

- **Throughput and response time**:
  - **Not challenging**
  - Future use may change that
  - Highly **scalable** runtime plane: **CloudHub**
- **HTTPS**:
  - **Document** in RAML definition
  - Ensure in **API implementation**
- **OAuth 2.0**:
  - Enforce with **API Manager**
  - Requires Identity Provider for **Client Management**
    - PingFederate
- **Consistency**:
  - Through **event notifications**

NFRs for "Submit auto claim"

- Request over HTTP with claim submission and **asynchronous processing** of the submission
  - Processing submission requires lengthy downstream processing steps
- **Performance**:
  - Ill-defined, aim for **10 requs/s**
  - **No response time requirement** because processing is asynchronous
- Reliability: claim submissions **must not be lost**
- **Consistency**:
  - Include claims in "Retrieve policy holder summary"
- **OAuth 2.0, HTTPS**



Meeting the NFRs for "Submit auto claim" using Anypoint Platform

New NFRs for this feature:

- **Async processing** of claim submission and no claim submission loss:
  - **Messaging system**
    - To trigger **async processing without message loss**
    - **Anypoint MQ**
    - Mule runtime **persistent VM queues** as in CloudHub
  - **Persistence mechanism**
    - To store async **correlation** information
    - Mule runtime **Object Store** as in CloudHub
- **Consistency**:
  - Through **event notifications**

Using API Manager and API policies to manage API invocations

Reviewing types of APIs

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- **REST** APIs
  - With API specification as **RAML** definition or **OAS** definition
  - **Without formal API specification**
  - **Hypermedia**-enabled REST APIs
- **Non-REST** APIs
  - GraphQL APIs
  - SOAP web services (APIs)
  - JSON-RPC, gRPC, …

API management on Anypoint Platform

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- Using **API Manager** and **API policies**
- On the level of **HTTP**
- Applicable to **all types of HTTP/1.x APIs**
  - Therefore not to WebSocket APIs or HTTP/2 APIs
- Special support for **RAML-defined APIs**
  - Allow definition of **resource-level** API policies
  - In addition to the **endpoint-level** API policies available for all APIs

Defining API policy

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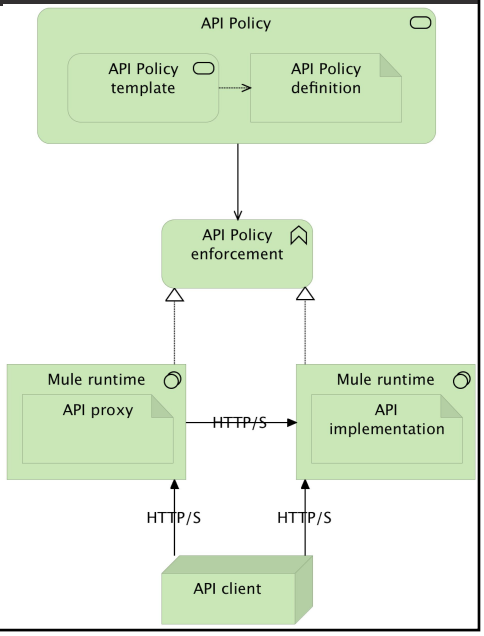
- Defines a typically **non-functional requirement**
- Applied to an **API** (instance)
- Injection into **API invocation** between API client and endpoint
  - Without changing API implementation
- Consists of
  - API policy **template** (code and parameter descriptions)
  - API policy **definition** (parameter values)

Enforcement of API policies

- On Anypoint Platform, API policies are always **enforced from within a Mule app**:
  - **API implementation** can **embed** enforcement of API policies
  - **API proxy** deployed infront of the API implementation proper to enforce API policies
- API policies **downloaded at runtime** from API Manager



Exercise: Pros and cons of policy enforcement sites

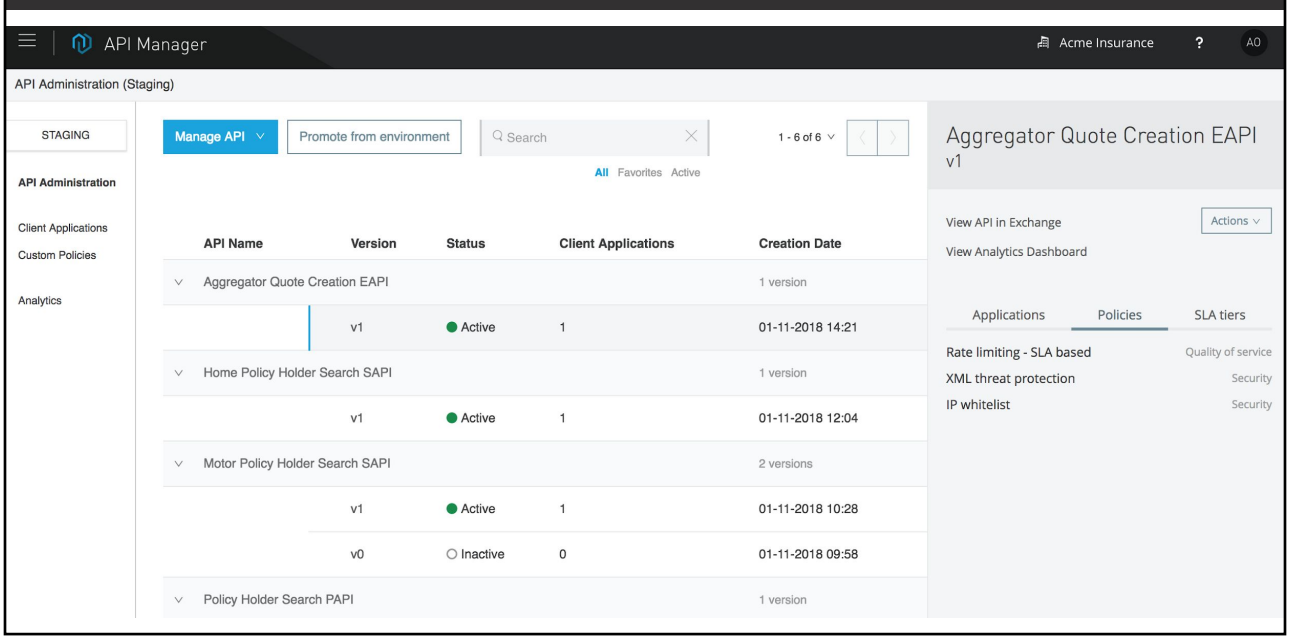
Compare the characteristics of the two sites of API policies enforcement available in Anypoint Platform:

- List scenarios/requirements that would be best addressed by API policy enforcement **embedded in the API implementation** or in an **API proxy**, respectively

Solution: Pros and cons of policy enforcement sites

- API implementations are **not Mule apps**
- **Resources** must be minized
- **Deployment and CI/CD** must be as simple as possible
- API policies with special **resource requirements** are applied
  - Caching API policy
  - Security API policy requiring HSM
- API policies require **special network configuration**
- **Security sensitive (Experience) APIs**
  - Deployment to **DMZ**
  - **Shield API implementations** from attacks

Managing APIs with API Manager



Managing APIs with API Manager

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- Management of APIs using **API instances**
  - **API instance** = endpoint for API with major version in environment
- Configuration of **API policies** for a given API instance
  - Select API policy template and parameterize it with API policy definition
  - **OOTB and custom** API policies
- Contacted from site of API policy enforcement to **download all API policies** that must be enforced
- Definition of **alerts** based on API invocations

Managing APIs with API Manager

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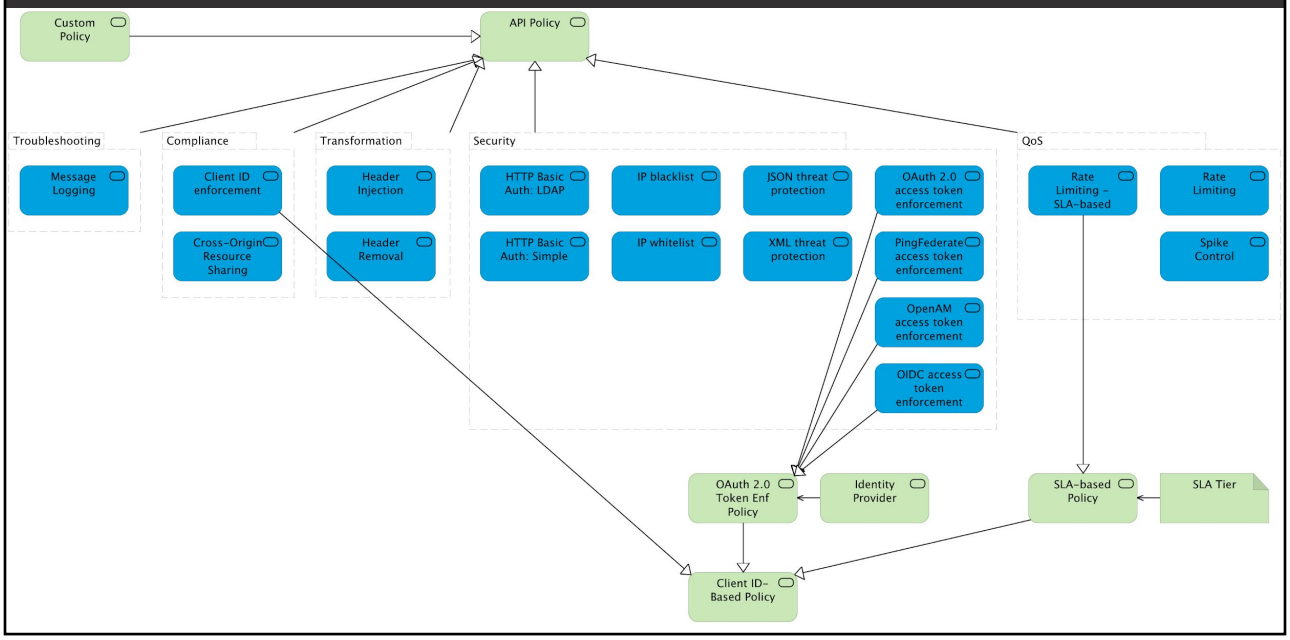
- Admin of **API clients** ("Client Applications")
  - API consumers use Exchange to request access
- API consumers use **Exchange to request access** to an API
- Access to Anypoint **Analytics**

Selectively applying an API policy to some resources and methods of an API

- By default API policies are applied to **entire API endpoint**
  - Represented as API instance in API Manager
- APIs defined with a RAML definition can apply API policies also to selected combinations of **API resources and HTTP methods**
- **OpenAPI** documents can be converted to **RAML definitions**

API policies



API policies as Aspect-Oriented Programming

- API policies are **AOP** applied to API invocations:
  - **Ordered**, API implementation/proxy as last element
  - **Incoming HTTP request** passed down this chain, returning **HTTP response** passed up
  - API policies implement "**around advice**":
    - Execute code **before/after** handing control to the **next element** in the chain
    - **Change HTTP request/response** if desired
  - In Mule 4: also applied to **outgoing HTTP requests**

Understanding custom API policies

- **Implementing and applying** custom API policies:
  - Very similar to **Mule apps**
  - Packaged and deployed to **Exchange**
    - Contains both **policy template** (code and parameter descriptions)
  - **API Manager** retrieves policy from Exchange and shows **configuration UI** to enter the definition (parameter values)
  - Policy template and definition **downloaded to any Mule runtime** that registers as that API instance

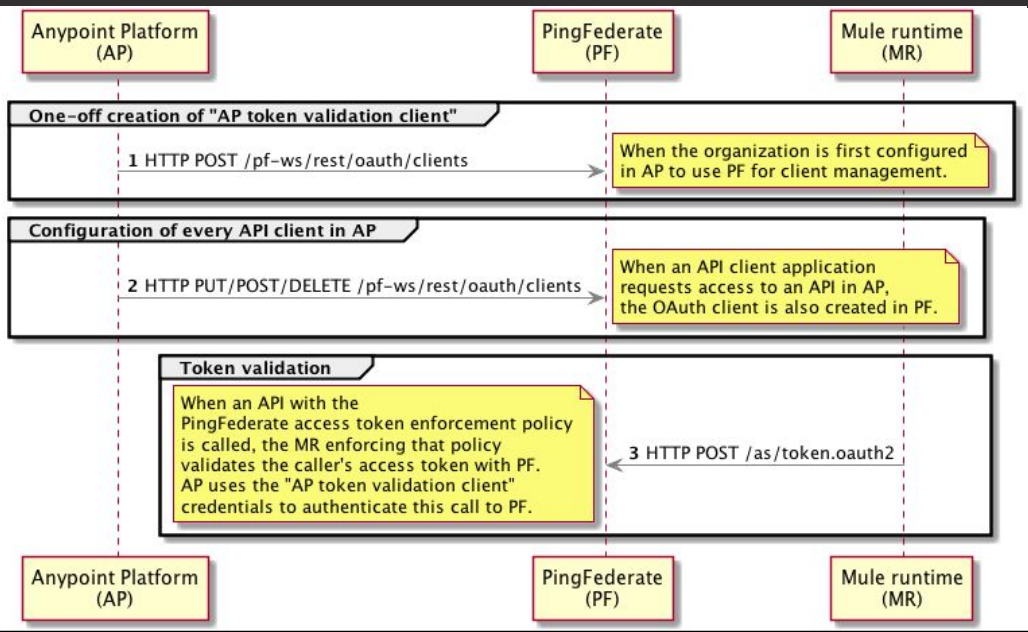
Compliance-related API policies

- **Client ID enforcement**
- **CORS control**
  - Interacts with API clients for **Cross-Origin Resource Sharing**:
    - Rejects HTTP requests whose **Origin** request header does not match configured origin domains
    - Sets **Access-Control-*** HTTP response headers to match configured cross-origins, usage of credentials, etc.
    - Responds to CORS pre-flight **HTTP OPTIONS requests**
  - Can be important for Experience APIs invoked from a **browser**

Security-related API policies

- Authentication/Authorization
  - **OAuth 2.0 token enforcement** API policies
    - Require matching Identity Provider configured for **Client Management**
      - OpenAM, PingFederate or OIDC DCR compatible (Okta)
    - Discouraged "OAuth 2.0 access token enforcement using external provider" requires access to Mule OAuth 2.0 provider or other configured in the policy
  - **Basic Authentication: LDAP/Simple**
    - Incorporate access to Identity Provider
- **IP-based** access control
  - **blacklisting, whitelisting**
- Payload **threat protection**
  - Guard against attacks sending over-sized HTTP request bodies
  - **Limit size of XML or JSON bodies**

Interactions with OAuth 2.0 Client Management



QoS-related API policies

- Quality of Service (QoS) related API policies on Anypoint Platform enforce **throughput limit** in # of API invocations per unit of time:
  - **Rate Limiting**: rejects requests above limit
  - **Spike Control**: queues requests above limit
- Two different ways to define the throughput limit:
  - **Non-SLA-based** (Rate Limiting and Spike Control)
    - Limit defined on API policy definition
    - Enforced for that API instance **across all API clients**
  - **SLA-based** (Rate Limiting)
    - Limit defined in an **SLA tier**
      - **API clients must register** with the API instance at a particular SLA tier
    - **Enforced separately** for each registered API client
      - API client must identify itself with **client ID**
- **X-RateLimit-*** HTTP response headers optionally inform API client of remaining capacity

Anypoint Platform SLA tiers for APIs

- SLA tiers
  - Enable **different API clients** to receive **different QoS**
  - Define one or more **throughput limits**
    - Per API client and API instance
- API instance with SLA tiers requires every **API client to register** for access with exactly one SLA tier
  - Manual or automatic **approval**
  - API clients must send **client ID/client secret** in API invocations
  - API client is promised the QoS offered by that SLA tier
- Enforcement by **SLA-based Rate Limiting** API policy
- Violation of SLA **monitored, reported and alerted-on**

Registering API clients with an Anypoint Platform-managed API

- API clients must **register to invoke** API instance with Client ID-based API Policies
  - Called "application" or "client application"
- Request access **through Exchange** entry for that API
  - Directly from Exchange or via Public (Developer) Portal
- Access **approval** is automatic or manual
- API consumer receives **client ID and client secret**
  - Must be supplied by that API client in all API invocations to that API version in that environment

Registering API clients with an Anypoint Platform-managed API

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Aggregator Quote Creation EAPI v1

Share Download Edit Request access

- Requires HTTPS mutual a

Request API access

Create a new application

Application	Aggregator
API Instance	Staging - v1:7484080
SLA tier	Standard

# of Reqs	Time period	Time Unit
1000	1	Second

Cancel | Request API access

Overview

Type	REST API
Created By	AnySurance Owner
Published On	Jan 11, 2018
Visibility	Private

Asset versions for v1

Version	Instances
1.0.1	Mocking Service Staging - v1:7484080

Registering API clients with an Anypoint Platform-managed API

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API Manager | Acme Insurance | ? | AO

API Administration (Staging) | Aggregator Quote Creation EAPI (v1) - Client Applications

STAGING

- API Administration
  - Alerts
  - **Client Applications**
  - Policies
  - SLA Tiers
  - Settings

Aggregator Quote Creation EAPI v1

Actions

API Status: Active Asset Version: 1.0.1 Type: RAML/OAS

Implementation URL: http://ans-aggregatorquotecreation-eapi.cloudhub.io/v1

Consumer endpoint: http://ans-aggregatorquotecreation-eapi.cloudhub.io/v1

View API in Exchange >

View configuration details >

View Analytics Dashboard >

Search

1 - 1 of 1

Application	Current SLA tier	Requested SLA tier	Status	
Aggregator	Standard	N/A	Approved	Revoke

Owners	AnySurance Owner anysurance+owner@googlegroups.com	**Submitted**	5 days ago
Client ID	552f92bfd0a94500b007c165fde8dbd2	**Approved**	5 days ago
URL	None	**Rejected**	-
Redirect URIs	None	**Revoked**	-

Client ID-based API policies

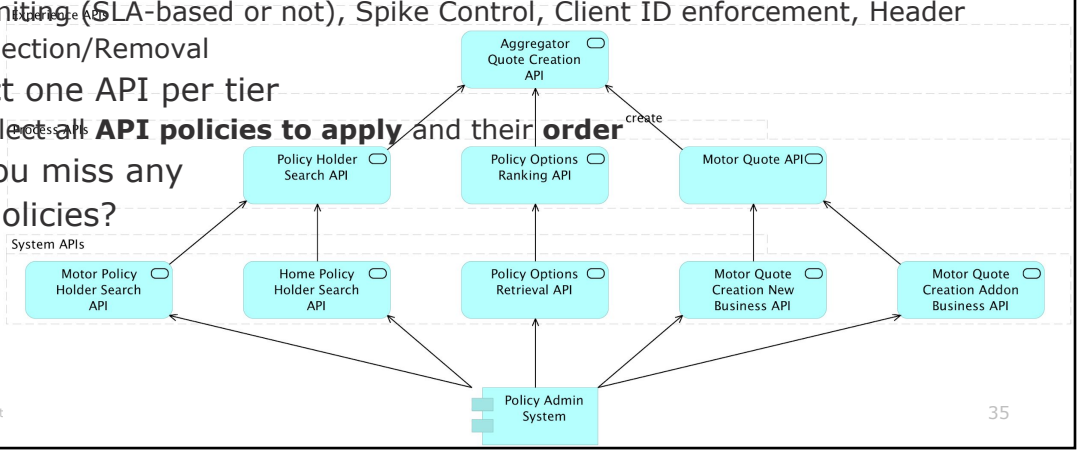
- API policies that require **API clients to identify** themselves:
  - **Client ID enforcement**
  - Rate Limiting - **SLA-based**
    - Retrieve SLA tier by client ID
      - Also enforce presence and validity of **client ID** and secret (optional)
  - **OAuth 2.0** access token enforcement
    - Token implicitly carries client ID
    - Policy **exchanges token for client ID** and passes it to SLA-based API policy
- **Client ID and client secret** passed in API invocations as defined by the API policy
  - **Query parameters**
  - Custom request **headers**
  - Standard **Authorization header** as in HTTP Basic Authentication

Transformation API policies

- To manipulate **HTTP headers** in requests and responses:
  - **Header Injection**
    - Values are **expressions** and hence dynamically evaluated
  - **Header Removal**
- For instance, to propagate transcation IDs as HTTP headers along chains of API invocations

Exercise: Select API policies for all tiers in Acme Insurance's application network

1. Using OOTB API policies
   - CORS, HTTP Basic Auth Simple/LDAP, IP black/whitelist, JSON/XML threat protection, PingFederate/OpenAM/OIDC access token enforcement, Rate Limiting (SLA-based or not), Spike Control, Client ID enforcement, Header Injection/Removal
2. Select one API per tier
   - Select all **API policies to apply** and their **order**
3. Do you miss any API policies?



Choosing appropriate API policies for System APIs

Policy Options Retrieval SAPI v1

Actions

API Status: Active Asset Version: 1.0.0 Type: RAML/OAS

Implementation URL: http://ans-policyoptionsretrieval-sapi.cloudhub.io/v1

Consumer endpoint: http://ans-policyoptionsretrieval-sapi.cloudhub.io/v1

View API in Exchange >

View configuration details >

View Analytics Dashboard >

Apply New Policy

Edit policy order

	Name	Category	Fulfills	Requires	
>	IP whitelist	Security	IP filtered		
>	Rate limiting - SLA based	Quality of service	SLA Rate Limiting, Client ID required		RAML snippet
>	Spike Control	Quality of service	Baseline Rate Limiting		

Choosing appropriate API policies for Process APIs

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Policy Holder Search PAPI v1

Actions

API Status: Active Asset Version: 1.0.3 Type: RAML/OAS

Implementation URL: http://ans-policyholdersearch-papi.cloudhub.io/v1

Consumer endpoint: http://ans-policyholdersearch-papi.cloudhub.io/v1

View API in Exchange >

View configuration details >

View Analytics Dashboard >

Apply New Policy

Edit policy order

	Name	Category	Fulfills	Requires	
>	IP whitelist	Security	IP filtered		
>	Client ID enforcement	Compliance	Client ID required		RAML snippet
>	Spike Control	Quality of service	Baseline Rate Limiting		

Choosing appropriate API policies for Experience APIs

MuleSoft

Aggregator Quote Creation EAPI v1

Actions

API Status: Active Asset Version: 1.0.1 Type: RAML/OAS

Implementation URL: http://ans-aggregatorquotecreation-eapi.cloudhub.io/v1

Consumer endpoint: http://ans-aggregatorquotecreation-eapi.cloudhub.io/v1

View API in Exchange >

View configuration details >

View Analytics Dashboard >

Apply New Policy

Edit policy order

	Name	Category	Fulfills	Requires	
>	IP whitelist	Security	IP filtered		
>	XML threat protection	Security	XML threat protected		
>	Rate limiting - SLA based	Quality of service	SLA Rate Limiting, Client ID required		RAML snippet

Choosing appropriate API policies for Experience APIs

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Mobile Policy Holder Summary ... v1

Actions

API Status: Unregistered Asset Version: 1.0.0 Type: RAML/OAS

Implementation URL: http://acmeins-mobilepolicyholdersummary-eapi.cloudhub.io/v1

Consumer endpoint: http://acmeins-mobilepolicyholdersummary-eapi.cloudhub.io/v1

View API in Exchange >

View configuration details >

Apply New Policy

Edit policy order

	Name	Category	Fulfills	Requires	
>	JSON threat protection	Security	JSON threat protected		
>	OAuth 2.0 access token enforcement using external provider	Security	OAuth 2.0 protected		RAML snippet
>	Client ID enforcement	Compliance	Client ID required		RAML snippet
>	Rate limiting	Quality of service	Baseline Rate Limiting		

API policies for "Create quote for aggregators"

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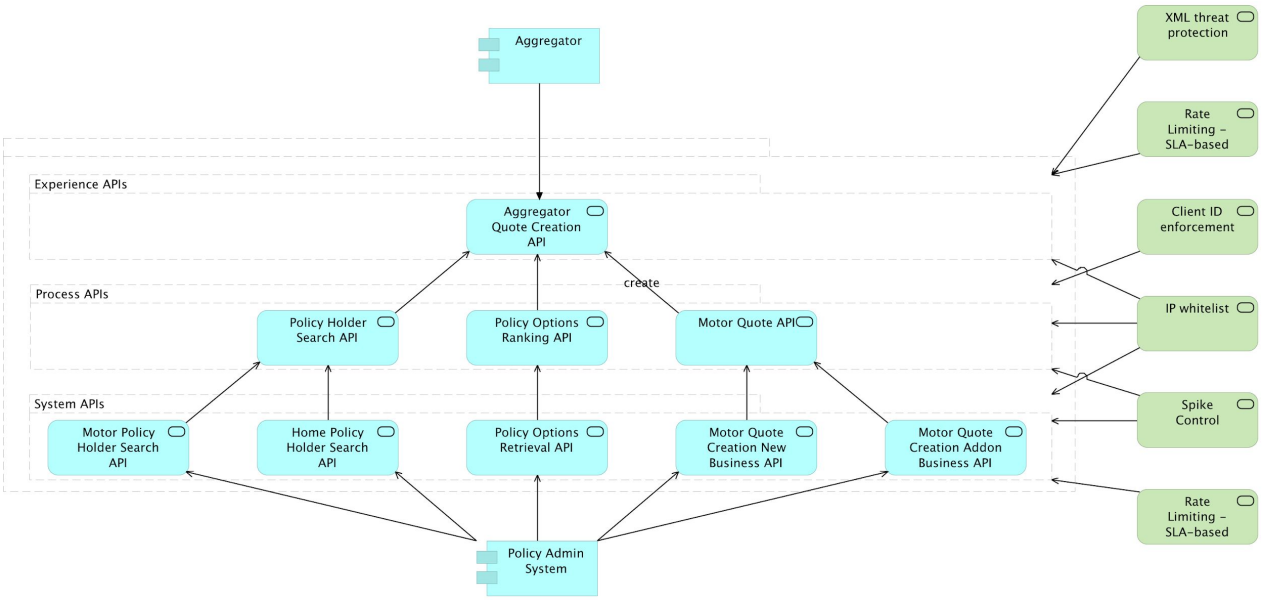
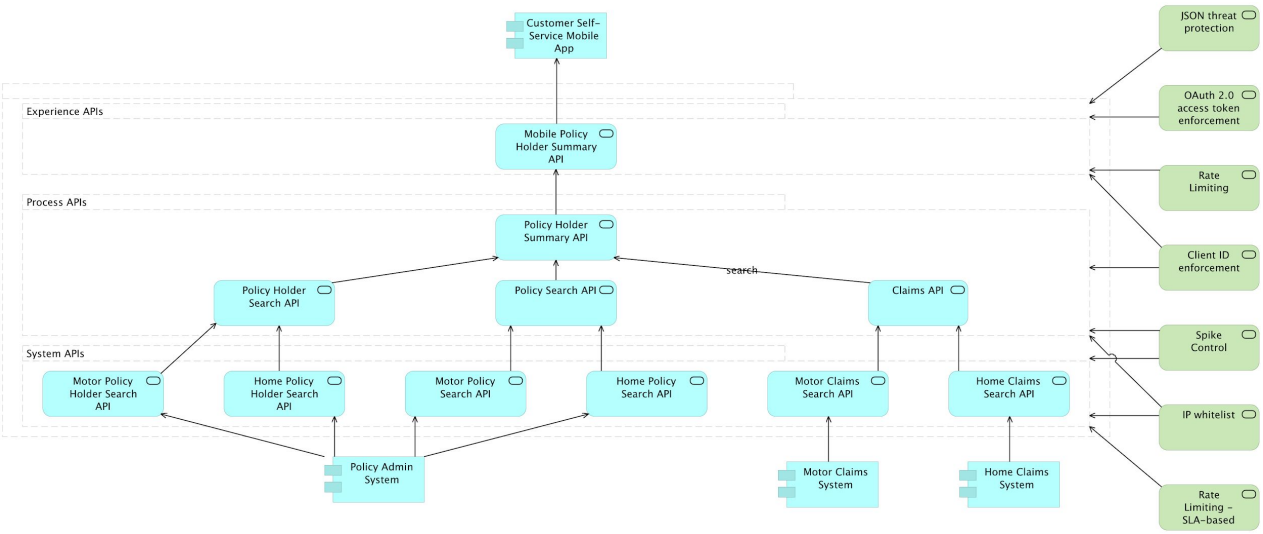
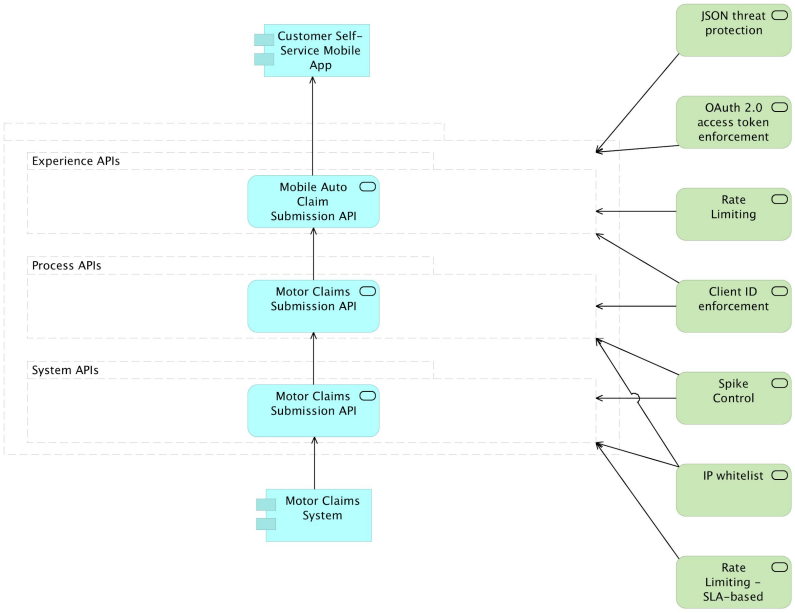


API policies for "Retrieve policy holder summary"



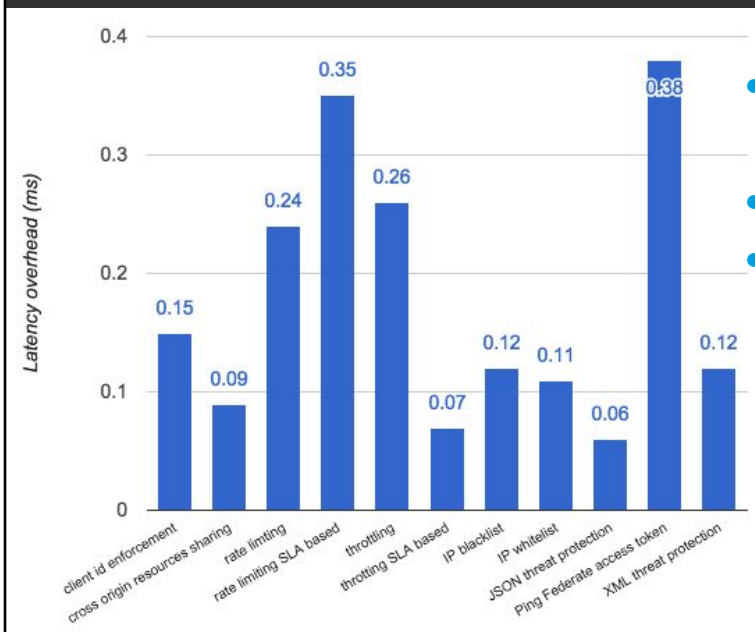
API policies for "Submit auto claim"



Reflecting the application of API policies in the RAML definition of an API

- Many API policies **change HTTP request/response**:
  - Require certain HTTP request headers: **Authorization**
  - Require certain query parameters: **client_id**
  - Add HTTP response headers: **X-RateLimit-Limit**
- **Change contract** between API client and API implementation
- Must be reflected in **RAML definition** of API
  - RAML has specific support for **securitySchemes** such as OAuth 2.0
  - In other cases define **RAML traits**
- **C4E** owns definition of reusable **RAML fragments**
  - Publish to **Exchange** to encourage consumption and reuse.

Latency overhead of applying API policies



- Increase in HTTP request-response latency
- through API policies
- enforced embedded in API implementation

Summary

Summary

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- **NFRs** for products are constraints on throughput, response time, security and reliability
- **API Manager and API policies** control invocations of APIs and impose non-functional constraints
- Compliance, Security, QoS, Transformation
- API policies **enforced**
  - Directly in an **API implementation** that is a Mule app
  - In an **API proxy**
- **Client ID**-based API policies require registered API clients
  - Must pass client ID/secret with every API invocation
- **C4E** defines guidelines for API policies and publishes matching reusable RAML fragments to Exchange