

aSET

Acrefine  
Seismic Engineering Tool

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# Table of Contents

<b>Changes</b>	<b>2</b>
<b>List of Abbreviations</b>	<b>3</b>
<b>1 Site Coefficient <math>F_a</math></b>	<b>5</b>
1.1 Linear interpolation between two known points . . . . .	5
1.2 $F_a$ functions . . . . .	5
<b>2 Site Coefficient <math>F_v</math></b>	<b>7</b>
2.1 $F_v$ functions . . . . .	7
<b>3 Equations</b>	<b>8</b>
<b>4 Sequence Diagrams</b>	<b>11</b>
4.1 Function Table . . . . .	11
4.2 Password Renewal . . . . .	12
4.3 Member Registration . . . . .	12
4.4 Product Selection . . . . .	13
4.5 Token Based Authentication . . . . .	13
<b>5 Network Diagram</b>	<b>16</b>
5.1 v1.x, v2.0 . . . . .	16
5.2 v2.1 and later . . . . .	16
5.3 v2.6 . . . . .	16
5.4 v3 (planning) . . . . .	17
<b>6 REST API Overview</b>	<b>18</b>
6.1 Health Check . . . . .	18
6.1.1 Liveness . . . . .	18
6.1.2 Readiness . . . . .	18
6.2 Authentication . . . . .	19
6.3 User . . . . .	19
6.4 Calculation . . . . .	19
6.4.1 Retrieve . . . . .	19
6.4.2 Perform . . . . .	20

## Changes

- May 31, 2019  $F_a$  calculation based on  $S_S$  values using linear interpolation has been added
- June 26, 2019  $F_v$  calculation based on  $S_1$  values using linear interpolation has been added
- June 26, 2019 Equations has been added
- July 25, 2019 Sequence diagrams has been added
- August 15, 2019 Flowchart of product selection process has been added
- October 07, 2019 Network diagram has been added
- January 30, 2020 List of abbreviations has been added.  $V_X$  and  $V_Y$  formulas has been updated
- January 31, 2020 Formulas has been updated
- February 06, 2020 Formulas has been added
- May 22, 2020 Long and Short Edge formulas has been added
- September 07, 2020 Vibration isolation formulas has been added
- October 02, 2020 Token based authentication procedure has been added
- October 07, 2020 REST API Overview has been added
- November 07, 2020 REST API Overview has been updated
- December 08, 2020 Update formulas and notations
- February 05, 2021 Added network diagram for v2.6
- February 26, 2021 Added new formulas and abbreviations

## List of Abbreviations

$F_a$	Site coefficient
$F_v$	Site coefficient
$S_S$	The mapped $MCE_R$ spectral response acceleration parameter at short periods
$S_1$	The mapped $MCE_R$ spectral response acceleration parameter at a period of 1 second
$S_{MS}$	The $MCE_R$ spectral response acceleration parameter at short period
$S_{M1}$	The $MCE_R$ spectral response acceleration parameter at a period of 1 second
$S_{DS}$	Design earthquake spectral response acceleration parameter at short period
$S_{D1}$	Design earthquake spectral response acceleration parameter at a period of 1 second
$a_P$	Component Amplification Factor
$I_P$	Component Importance Factor
$R_P$	Component Response Modification Factor
$z$	Height in structure of point of attachment of component with respect to the base
$h$	Total height of the building from ground
$g$	Gravitational acceleration (Yercekimi ivmesi), $9.81m/s^2$
$G_x$	Design Horizontal Seismic Acceleration
$G_y$	Design Vertical Seismic Acceleration
$W_P$	Operating weight of component
$F_P$	Horizontal seismic design force
$F_{P(max)}$	Horizontal seismic design force (max)
$F_{P(min)}$	Horizontal seismic design force (min)
$F_{PV}$	Vertical seismic design force
$e_x$	Eccentricity along X-X
$e_y$	Eccentricity along Y-Y
$d_1$	Distance between restraints along Y-Y
$d_2$	Distance between restraints along X-X
$I_{XX}$	$mm^3$

$I_{YY}$	$mm^3$
$\Theta_t$	$F_P$ Direction Angle (degree)
$\Theta_S$	$F_P$ Direction Angle (degree)
$H_{CG}$	Height to center of gravity
$N$	Number of restraint
$N_X$	Restraint Quantity acting against horizontal seismic force along X-X
$N_Y$	Restraint Quantity acting against horizontal seismic force along Y-Y
$T$	Maximum tension force on restraint
$V$	Maximum shear force on restraint
$V_X$	
$V_Y$	
$t$	Thickness of chassis-frame, $mm$
$f_d$	Disturbing frequency, $rpm$
$f_n$	Natural frequency of the system, $Hz$
$\delta_{st}$	Isolator static deflection
$T$	Vibration transmissibility
$E_{min}$	Required minimum vibration isolation efficiency
$\delta_{min}$	Minimum isolator static deflection capacity required, $mm$
$M$	Total mass per isolator
$Et, ff$	Isolator efficiency
$\delta$	Isolator deflection
$t$	Isolator thickness
$t_{air}$	Air gap thickness
$f_{rm}$	Ruber mount natural frequency
$f_{air}$	Air gap natural frequency
$f_n$	Floating floor system natural frequency

# 1 Site Coefficient $F_a$

Table 1: Values of  $F_a$  as a Function of Site Class and Mapped Short-Period MCE Spectral Acceleration

Site Class	$S_S \leq 0.25$	$S_S = 0.5$	$S_S = 0.75$	$S_S = 1.0$	$S_S \geq 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	-	-	-	-	-

Note: Use straight-line interpolation for intermediate values of  $S_S$ .

## 1.1 Linear interpolation between two known points

If the two known points are given by the coordinates  $(x_0, y_0)$  and  $(x_1, y_1)$ , the **linear interpolant** is the straight line between these points. For a value  $x$  in the interval  $(x_0, x_1)$ , the value  $y$  along the straight line is given from the equation of slopes

$$\frac{y - y_0}{x - x_0} = \frac{y_1 - y_0}{x_1 - x_0}$$

## 1.2 $F_a$ functions

Piecewise-defined functions are as below.

$$F_a = 0.8, \quad (\text{Site Class A})$$

$$F_a = 1.0, \quad (\text{Site Class B})$$

$$F_a = \begin{cases} 1.2 & \text{if } S_S \leq 0.5, \\ \frac{-0.1S_S + 0.35}{0.25} & \text{if } 0.5 \leq S_S \leq 1.0, \\ 1.0 & \text{if } S_S \geq 1.0, \end{cases} \quad (\text{Site Class C})$$

$$F_a = \begin{cases} 1.6 & \text{if } S_S \leq 0.25, \\ \frac{-0.2S_S + 0.45}{0.25} & \text{if } 0.25 \leq S_S \leq 0.75, \\ \frac{-0.1S_S + 0.375}{0.25} & \text{if } 0.75 \leq S_S \leq 1.25, \\ 1.0 & \text{if } S_S \geq 1.25, \end{cases} \quad (\text{Site Class D})$$

$$F_a = \begin{cases} 2.5 & \text{if } S_S \leq 0.25, \\ \frac{-0.8S_S + 0.825}{0.25} & \text{if } 0.25 \leq S_S \leq 0.5, \\ -2S_S + 2.7 & \text{if } 0.5 \leq S_S \leq 0.75, \\ \frac{-0.3S_S + 0.525}{0.25} & \text{if } 0.75 \leq S_S \leq 1.0, \\ 0.9 & \text{if } S_S \geq 1.0, \end{cases} \quad (\text{Site Class E})$$

## 2 Site Coefficient $F_v$

Table 2: Values of  $F_v$  as a Function of Site Class and Mapped Long-Period MCE Spectral Acceleration

Site Class	$S_1 \leq 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \geq 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	-	-	-	-	-

Note: Use straight-line interpolation for intermediate values of  $S_1$ .

### 2.1 $F_v$ functions

Piecewise-defined functions are as below.

$$F_v = 0.8, \quad (\text{Site Class A})$$

$$F_v = 1.0, \quad (\text{Site Class B})$$

$$F_v = \begin{cases} 1.7 & \text{if } S_1 \leq 0.1, \\ -S_1 + 1.8 & \text{if } 0.1 \leq S_1 \leq 0.5, \\ 1.3 & \text{if } S_1 \geq 0.5, \end{cases} \quad (\text{Site Class C})$$

$$F_v = \begin{cases} 2.4 & \text{if } S_1 \leq 0.1, \\ -4S_1 + 2.8 & \text{if } 0.1 \leq S_1 \leq 0.2, \\ -2S_1 + 2.4 & \text{if } 0.2 \leq S_1 \leq 0.4, \\ -S_1 + 2.0 & \text{if } 0.4 \leq S_1 \leq 0.5, \\ 1.5 & \text{if } S_1 \geq 0.5, \end{cases} \quad (\text{Site Class D})$$

$$F_v = \begin{cases} 3.5 & \text{if } S_1 \leq 0.1, \\ -3S_1 + 3.8 & \text{if } 0.1 \leq S_1 \leq 0.2, \\ -4S_1 + 4.0 & \text{if } 0.2 \leq S_1 \leq 0.4, \\ 2.4 & \text{if } S_1 \geq 0.4, \end{cases} \quad (\text{Site Class E})$$



### 3 Equations

$$S_{MS} = F_a \times S_s$$

$$S_{M1} = F_v \times S_1$$

$$S_{DS} = S_{MS} \times \frac{2}{3}$$

$$S_{D1} = S_{M1} \times \frac{2}{3}$$

$$G_x = \frac{0.4 \times a_P \times S_{DS} \times I_P}{R_P} \times \left(1 + 2 \times \frac{z}{h}\right)$$

$$G_{x(max)} = 1.6 \times S_{DS} \times I_P$$

$$G_{x(min)} = 0.3 \times S_{DS} \times I_P$$

$$G_y = \pm 0.2 \times S_{DS}$$

$$F_P = G_x \times W_P = \frac{0.4 \times a_P \times S_{DS} \times W_P \times I_P}{R_P} \times \left(1 + 2 \times \frac{z}{h}\right)$$

$$F_{P(max)} = G_{x(max)} \times W_P = 1.6 \times S_{DS} \times I_P \times W_P$$

$$F_{P(min)} = G_{x(min)} \times W_P = 0.3 \times S_{DS} \times I_P \times W_P$$

$$F_{PV} = G_y \times W_P = \pm 0.2 \times S_{DS} \times W_P$$

$$e_X = L - (L_{CG}/2)$$

$$e_Y = W - (W_{CG}/2)$$

$$d_1 = L - 300$$

$$d_2 = W - 150$$

$$I_{XX} = N(N+2)d_1^2/(12(N-2))$$

$$I_{YY} = N * d_2^2/4$$

$$\Theta_t = \tan^{-1}((I_{YY}d_1)/(I_{XX}d_2)), \quad (\text{in radians } ^\circ)$$

$$\Theta_t = \tan^{-1}((I_{YY}d_1)/(I_{XX}d_2)) \times 180/\pi, \quad (\text{in degree } ^\circ)$$

$$\Theta_S = \tan^{-1}(e_X/e_Y), \quad (\text{in radians } ^\circ)$$

$$\Theta_S = \tan^{-1}(e_X/e_Y) \times 180/\pi, \quad (\text{in degree } ^\circ)$$

$$N = \begin{cases} (\lceil \frac{L}{1500} \rceil + 1)2 & \text{FORMULA1 for product groups except AS-C, AS-Z} \\ (\lceil \frac{L}{1500} \rceil + 1)2 + 2N_Y & \text{FORMULA2 for AS-C, AS-Z} \end{cases}$$

$$N_X = \begin{cases} N & \text{FORMULA1 for product groups except AS-A, AS-AR, AS-B, AS-U, AS-C, AS-Z} \\ N/2 & \text{FORMULA2 for AS-A, AS-AR, AS-B, AS-U} \\ (N - 2N_Y)/2 & \text{FORMULA3 for AS-C, AS-Z} \end{cases}$$

$$N_Y = \begin{cases} N & \text{FORMULA1 for product groups except AS-C, AS-Z} \\ 2 & \text{FORMULA2 for AS-C, AS-Z} \end{cases}$$

$$T = \frac{F_{PV}}{N} + \left[ \frac{-F_{PV}}{d_1 d_2} \left[ \frac{d_1}{2} e_X + \frac{d_2}{2} e_Y - e_X e_Y \right] \right] + \frac{0.7 F_P \cos \Theta_t H_{CG} \frac{d_2}{2}}{I_{YY}} + \frac{0.7 F_P \sin \Theta_t H_{CG} \frac{d_1}{2}}{I_{XX}}$$

$$V_X = \frac{0.7 F_P \cos \Theta_S}{N_X} + \frac{0.7 F_P \cos \Theta_S e_Y d_2 + 0.7 F_P \sin \Theta_S e_X d_1}{2(I_{XX} + I_{YY})}$$

$$V_Y = \frac{0.7 F_P \sin \Theta_S}{N_Y} + \frac{0.7 F_P \cos \Theta_S e_Y d_1 + 0.7 F_P \sin \Theta_S e_X d_2}{2(I_{XX} + I_{YY})}$$

$$V = \sqrt{V_X^2 + V_Y^2}$$

$$\left( \frac{T}{T_{R,alw}} \right) + \left( \frac{V}{V_{R,alw}} \right) \leq 1.0, \quad (\text{Capacity Control for isolators and snubbers})$$

$$T_b = \begin{cases} \frac{VH_b}{\frac{N_b}{2} \times \left[ a+b+\frac{a^2}{a+b} \right]} + \frac{T-\frac{WP}{N}}{N_b} & \text{FORMULA1 for isolators} \\ \frac{VH_b+TW_b}{N_b \frac{W_b}{2}} & \text{FORMULA2 for snubbers except AS-AR (AS-AR-10000)} \\ \frac{VH_b+TW_b}{\frac{N_b}{2} \times \left[ a+b+\frac{a^2}{a+b} \right]} & \text{FORMULA3 for AS-AR (AS-AR-10000 only)} \end{cases}$$

$$V_b = \frac{V}{N_b}$$

$$\left( \frac{T_b}{T_{alw}} \right)^{\frac{5}{3}} + \left( \frac{V_b}{V_{alw}} \right)^{\frac{5}{3}} \leq 1.0, \quad (\text{Capacity Control for bolts})$$

$$d = \begin{cases} \frac{L}{\frac{N-2N_Y}{2}-1} & \text{Distance at long edge for AS-C and AS-Z} \\ \frac{L}{\frac{N}{2}-1} & \text{Distance at long edge except AS-C and AS-Z} \end{cases}$$

$$d_Y = \frac{W}{N_Y - 1}, \quad (\text{Distance at short edge for AS-C and AS-Z only})$$

$$d \geq 1000\text{mm}, \quad (\text{Distance at long edge control})$$

$$d_Y \geq 500\text{mm}, \quad (\text{Distance at short edge control})$$

$$f_d\{Hz\} = f_d\{rpm\}/60$$

$$f_n = \frac{1}{2\pi} \sqrt{\frac{k}{m}} = \frac{1}{2\pi} \sqrt{\frac{g}{\delta_{st}} \frac{1000\{mm\}}{1\{m\}}} = \frac{15.76}{\sqrt{\delta_{st}\{mm\}}}$$

$$T = \left| \frac{1}{1 - \left( \frac{f_d}{f_n} \right)^2} \right|$$

$$f_n = \sqrt{f_{rm}^2 + f_a^2}$$

## 4 Sequence Diagrams

### 4.1 Function Table

**Confirmation vs. Verification:** Confirmation requires a re-issuance of a believed statement whilst Verification requires external evidence. Therefore we are going to use "Confirmation" term when we double-check something we already think is true, and "Verification" term when we need proof for something we are not sure of.

Table 3: Function Table of the System

function	status	actions
reset-password	email not exist	e"There is no account linked to this email address."
	UNCONFIRMED	send account confirmation email to user i"Account confirmation email has been sent to {0}"
	CONFIRMED	send approval request email to sysadmin i"Your application has been submitted. You will be contacted soon."
	REJECTED	e"We regret to inform you that your application has been rejected due to our Terms of Use. If you believe your rejection has occurred mistakenly, you may contact us."
verify	APPROVED	send reset password request confirmation email to user i"Request confirmation email has been sent to 0"
	reset-password	reset password send password renewal (login information) email to user i"Your login information has been sent to 0"
registration	email not exist	if Terms of Use is not accepted, e"Please accept terms of use" if user exists, i"User is already registered" create UNCONFIRMED account send account confirmation email to user i"Account confirmation email has been sent to {0}"
verify	account-confirmation	confirm account

Continuation of Table 3		
function	status	actions
		i"Your application has been submitted. You will be contacted soon."
login	email not exist	e"There is no account linked to this email address."
	UNCONFIRMED	send account confirmation email to sysadmin i"Account confirmation email has been sent to {0}"
	CONFIRMED	send approval request email to sysadmin i"Your application has been submitted. You will be contacted soon."
	REJECTED	e"We regret to inform you that your application has been rejected due to our Terms of Use. If you believe your rejection has occurred mistakenly, you may contact us."
	APPROVED	login to the system
End of Table 3		

## 4.2 Password Renewal

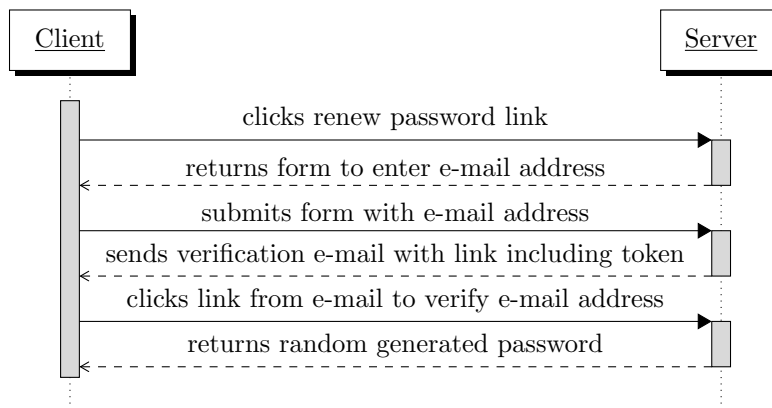


Figure 1: Sequence diagram for password renewal

## 4.3 Member Registration

Find sequence diagram for member registration in Figure 2

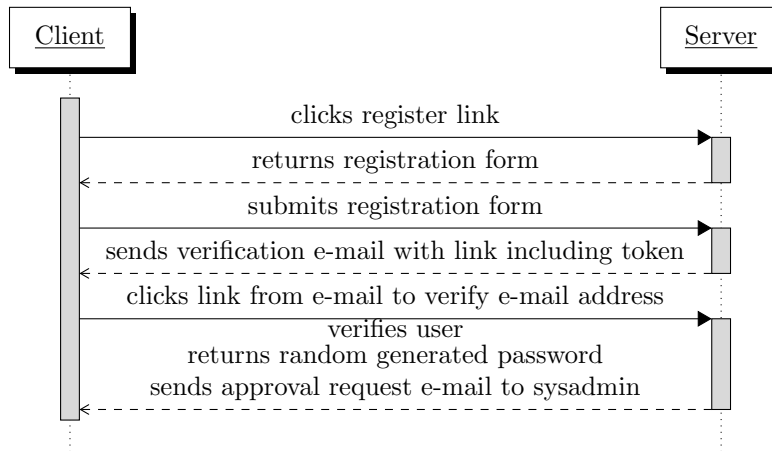


Figure 2: Sequence diagram for member registration

#### 4.4 Product Selection

Find flowchart of product selection process in Figure 3

#### 4.5 Token Based Authentication

In token-based authentication shown in Figure 4, the client exchanges *hard credentials* (such as username and password) for a piece of data called *token*. For each request, instead of sending the hard credentials, the client will send the token to the server to perform authentication and then authorization. **The validity period of the generated token is 1 hour.**

Authentication scheme based on tokens follow these steps:

1. The client sends their credentials (username and password) to the server.
2. The server authenticates the credentials and, if they are valid, generate a token for the user.
3. The server stores the previously generated token in storage along with the user identifier and an expiration date.
4. The server sends the generated token to the client.
5. The client sends the token to the server in each request.
6. The server, in each request, extracts the token from the incoming request. With the token, the server looks up the user details to perform authentication.
  - If the token is valid, the server accepts the request.
  - If the token is invalid, the server refuses the request.

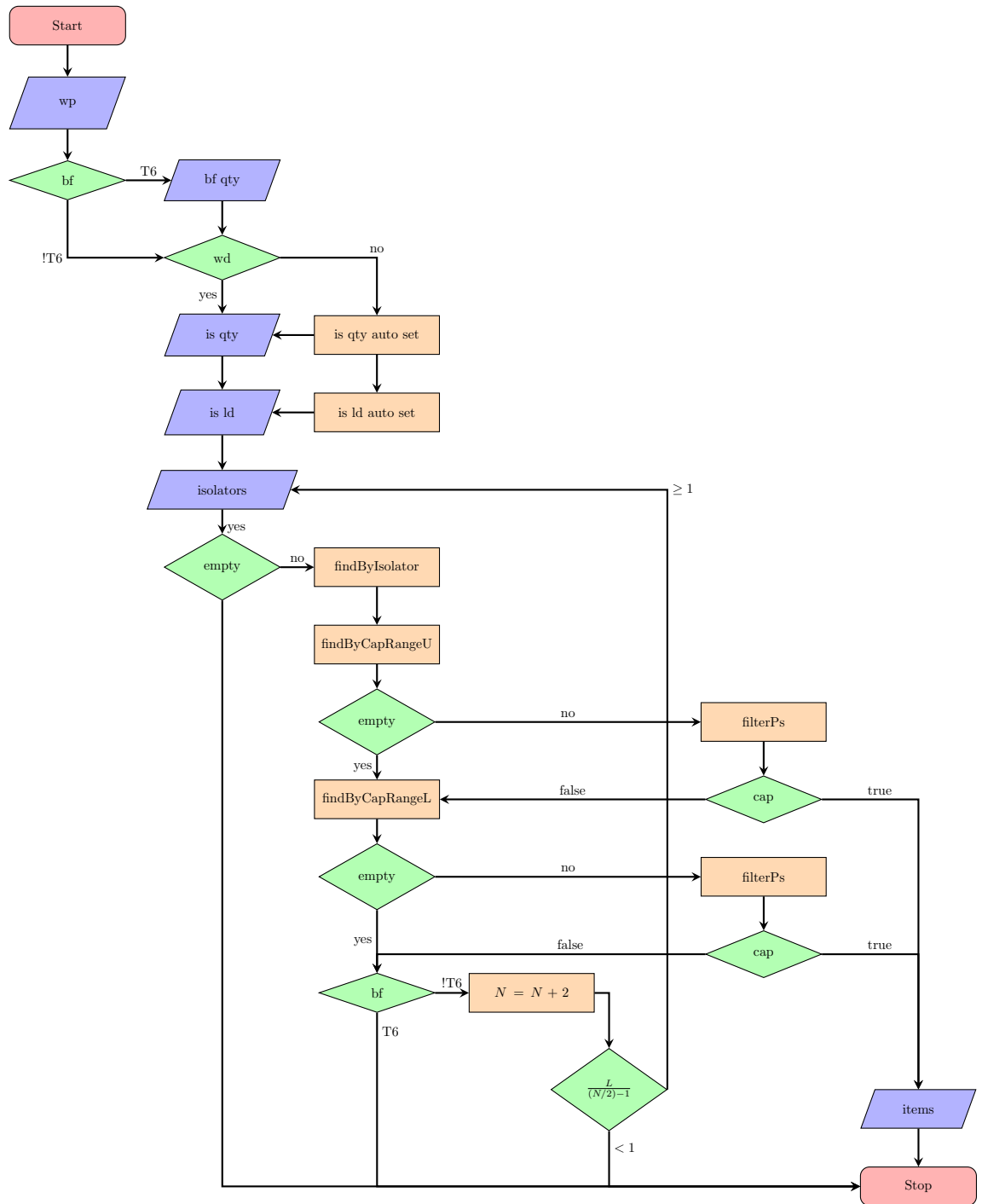


Figure 3: Flowchart of product selection process

7. Once the authentication has been performed, the server performs authorization.
- If the authorization is valid, the server accepts the request.
  - If the authorization is invalid, the server refuses the request.

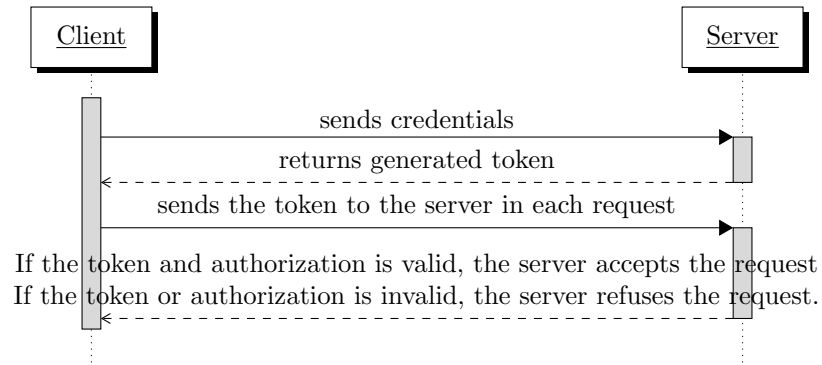


Figure 4: Token Based Authentication



## 5 Network Diagram

### 5.1 v1.x, v2.0

Find network diagram for v1.x, v2.0 in Figure 5

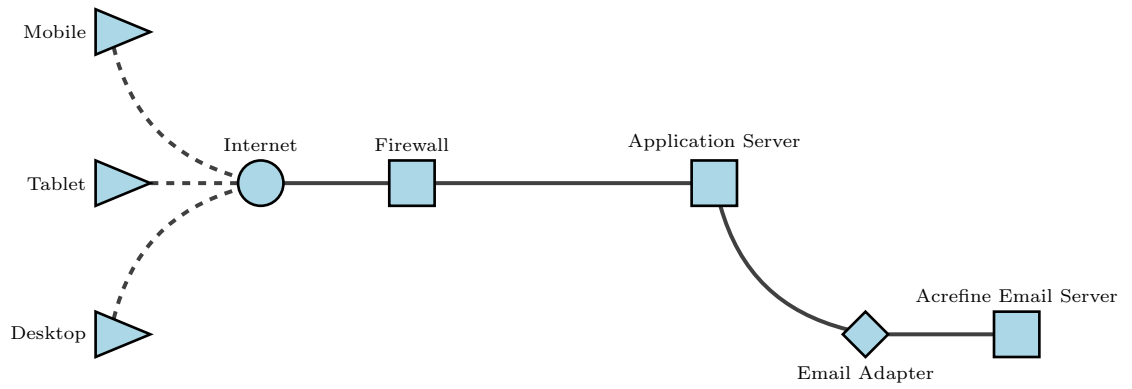


Figure 5: Network Diagram for v1, v2

### 5.2 v2.1 and later

Find network diagram for v2.1 and later in Figure 6

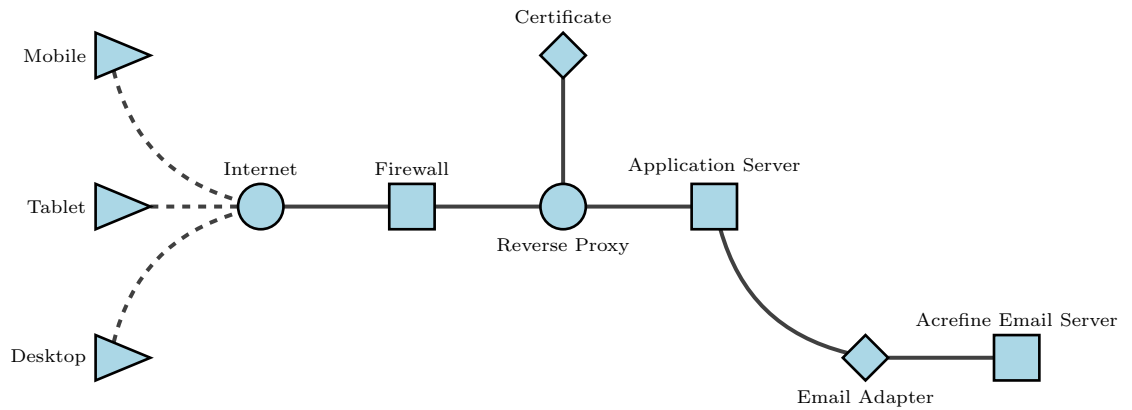


Figure 6: Network Diagram for v2.1

### 5.3 v2.6

Find network diagram for v2.6 in Figure 7

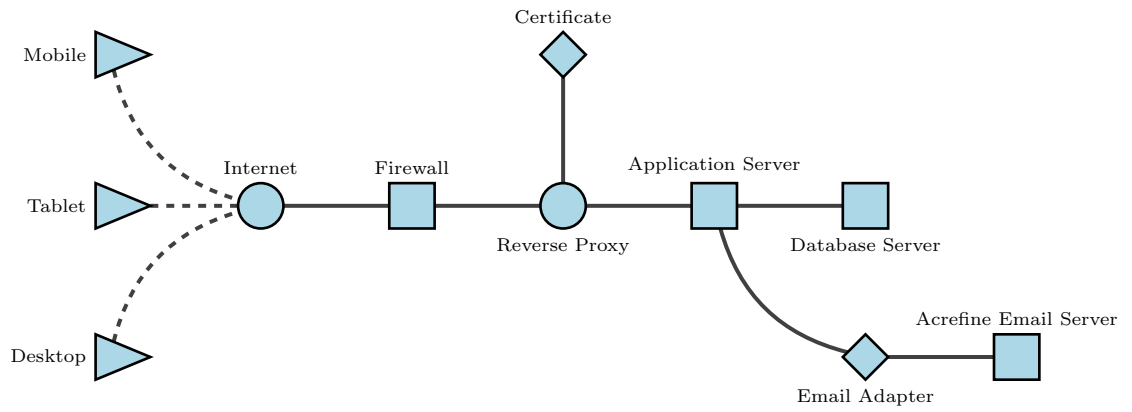


Figure 7: Network Diagram for v2.6

### 5.4 v3 (planning)

Find network diagram for v3 in Figure 8

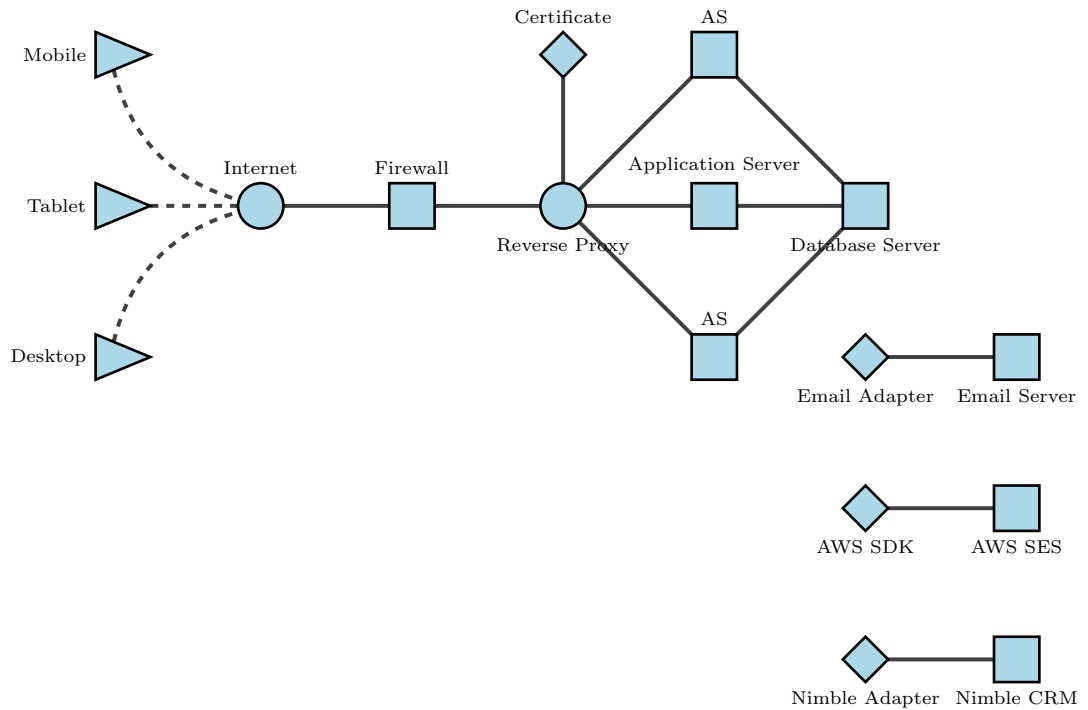


Figure 8: Network Diagram for v3

## 6 REST API Overview

See the *curl* scripts below with the REST API supported operations:

### 6.1 Health Check

It accumulates all health check procedures in the application. No authentication is required to perform this operation.

```
curl -X GET 'https://aset.acrefine.com/health'
```

The response format is going to be:

```
{"status": "UP", "checks": []}
```

#### 6.1.1 Liveness

It checks if the application is up and running. No authentication is required to perform this operation.

```
curl -X GET 'https://aset.acrefine.com/health/live'
```

The response format is going to be:

```
{"status": "UP", "checks": []}
```

#### 6.1.2 Readiness

It checks if the application is ready to serve requests. No authentication is required to perform this operation.

```
curl -X GET 'https://aset.acrefine.com/health/ready'
```

The response format is going to be:

```
{"status": "UP", "checks": []}
```

## 6.2 Authentication

Exchange hard credentials for an authentication token. Valid credentials must be sent in the request payload to be exchanged for a token. **The validity period of the generated token is 1 hour.**

```
curl -X POST \  
  'https://aset.acrefine.com/api/authentication' \  
  -H 'Accept: application/json' \  
  -H 'Content-Type: application/json' \  
  -d '{  
    "username": "<username>",  
    "password": "<password>"  
  }'
```

The response format is going to be:

```
<authentication-token>
```

## 6.3 User

Get the current user. No authentication is required to perform this operation. However, if the request is performed with a valid token, the server will return details for the current user.

```
curl -X GET \  
  'https://aset.acrefine.com/api/users/me' \  
  -H 'Accept: application/json' \  
  -H 'Authorization: Bearer <authentication-token>'
```

The response format is going to be:

```
<username>
```

## 6.4 Calculation

### 6.4.1 Retrieve

Get the calculation for the given id. Request is performed with a valid token, the server will return details for the calculation.

```
curl -X GET \  
  'https://aset.acrefine.com/api/calculations/<id>' \  
  -H 'Accept: application/json' \  
  -H 'Authorization: Bearer <authentication-token>'
```

The response format is going to be:

```
{"capacityKg":1140.0,"id":39,"n":12,"productCode":"ASI-T1-1B-1140"}
```

#### 6.4.2 Perform

Perform calculation for the given parameters. Request is performed with a valid token, the server will return the product recommendation for the given parameters.

```
curl -X POST \  
  'https://aset.acrefine.com/api/calculations/perform' \  
  -H 'Accept: application/json' \  
  -H 'Content-Type: application/json' \  
  -H 'Authorization: Bearer <authentication-token>' \  
  -d '{  
    "componentCode": "<componentCode>",  
    "length": "<length>",  
    "width": "<width>",  
    "height": "<height>",  
    "weight": "<weight>",  
    "productGroupCode": "<productGroupCode>"  
  }'
```

The response format is going to be:

```
{"capacityKg":1140.0,"id":39,"n":12,"productCode":"ASI-T1-1B-1140"}
```