

Virtualized Network Functions Description, Publication and Discovery: Content Delivery Networks as Case Study

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Supervisors:

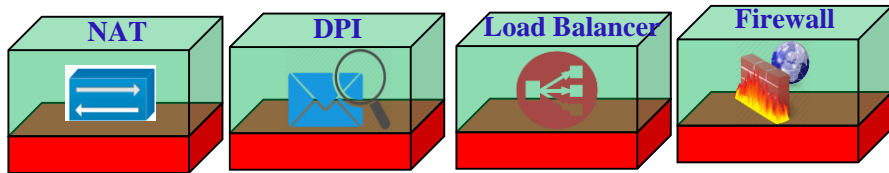
- Sami YANGUI,
- Noura FACI,
- Khalil DRIRA,
- Said TAZI

Seminar STORE , Feb 18, 2019, ENAC, Toulouse.

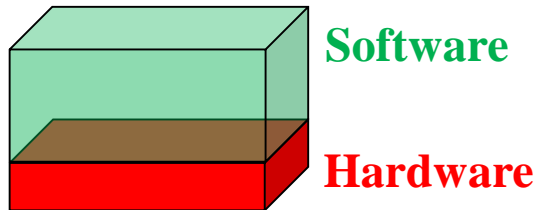
- Context
- Motivating use case and Requirements
- Proposed System Architecture
 - A novel VNF description model/language
 - A novel VNF Discovery approach
- Validation & Evaluation
- Lessons learned & Next steps

Network Function Virtualization (NFV)

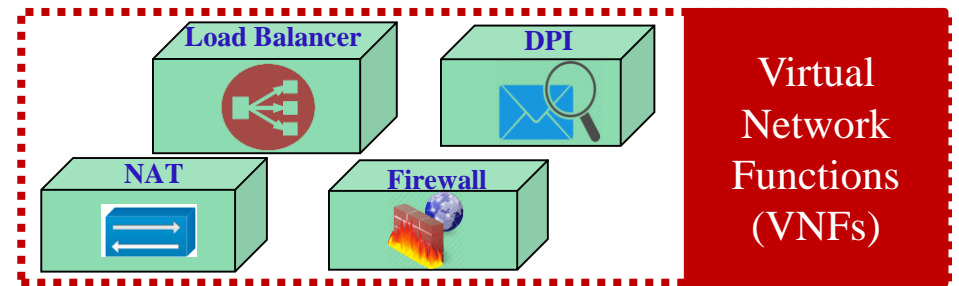
Traditional Network Model: APPLIANCE APPROACH



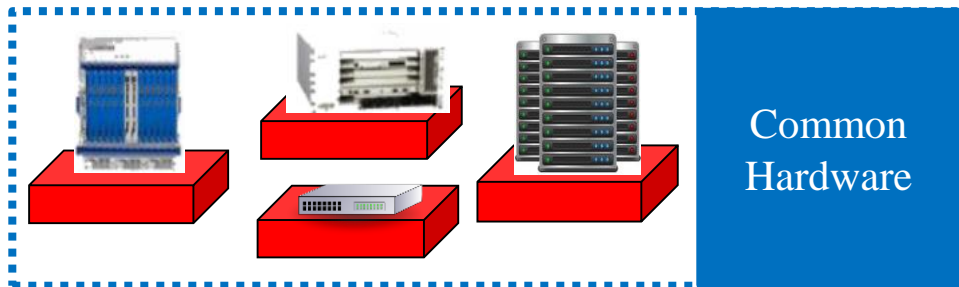
Specialized appliances



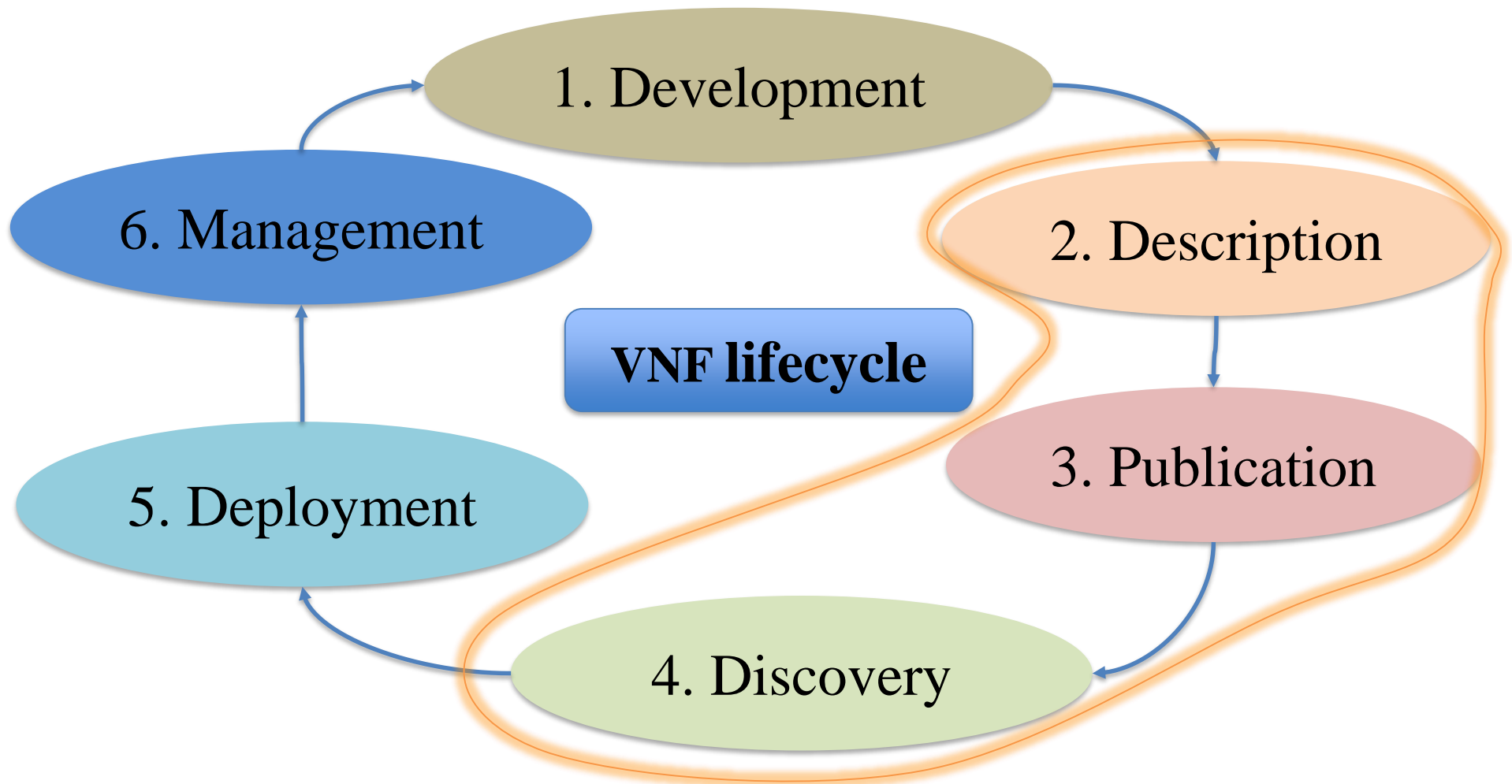
Virtualized Network Model: VIRTUAL APPLIANCE APPROACH



Orchestrated, Automatic & Remote install



Virtualized Network Function lifecycle



Source: M. Jacobs, P. Leydekkers, "Specification of synchronization in multimedia conferencing services using the TINA lifecycle model", *Distrib. Syst. Eng.*, vol. 3, 1996, pp. 185–196.

NFV Applications and use cases

The high level cases selected by the NFV ETSI ISG

(1) Network Functions Virtualization Infrastructure as a Service,

(2) *Virtual Network Functions as a Service,*

(3) Virtual Network Platform as a Service,

(4) VNF (Virtual Network Functions) Forwarding Graphs,

(5) Virtualization of Mobile Core Network and IMS,

(6) Virtualization of Mobile Base Station,

(7) Virtualization of the Home Environment,

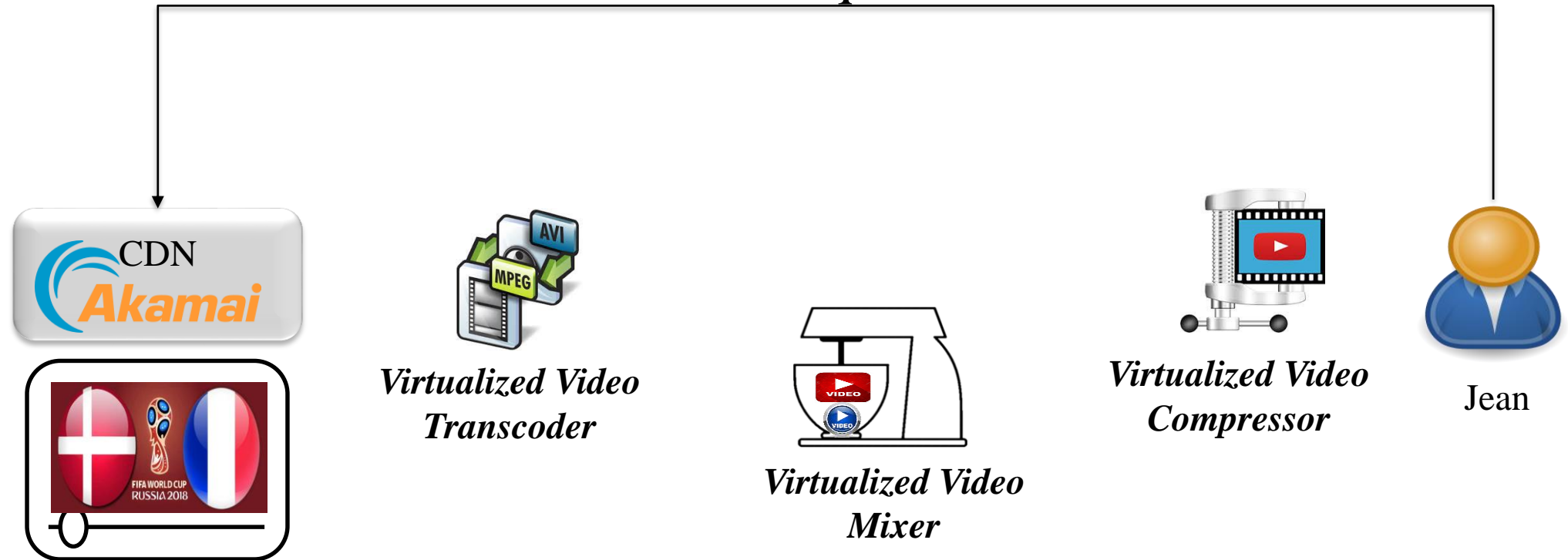
(8) *Virtualization of CDNs,*

(9) Fixed Access Network Functions Virtualization.

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VNFs use in CDN

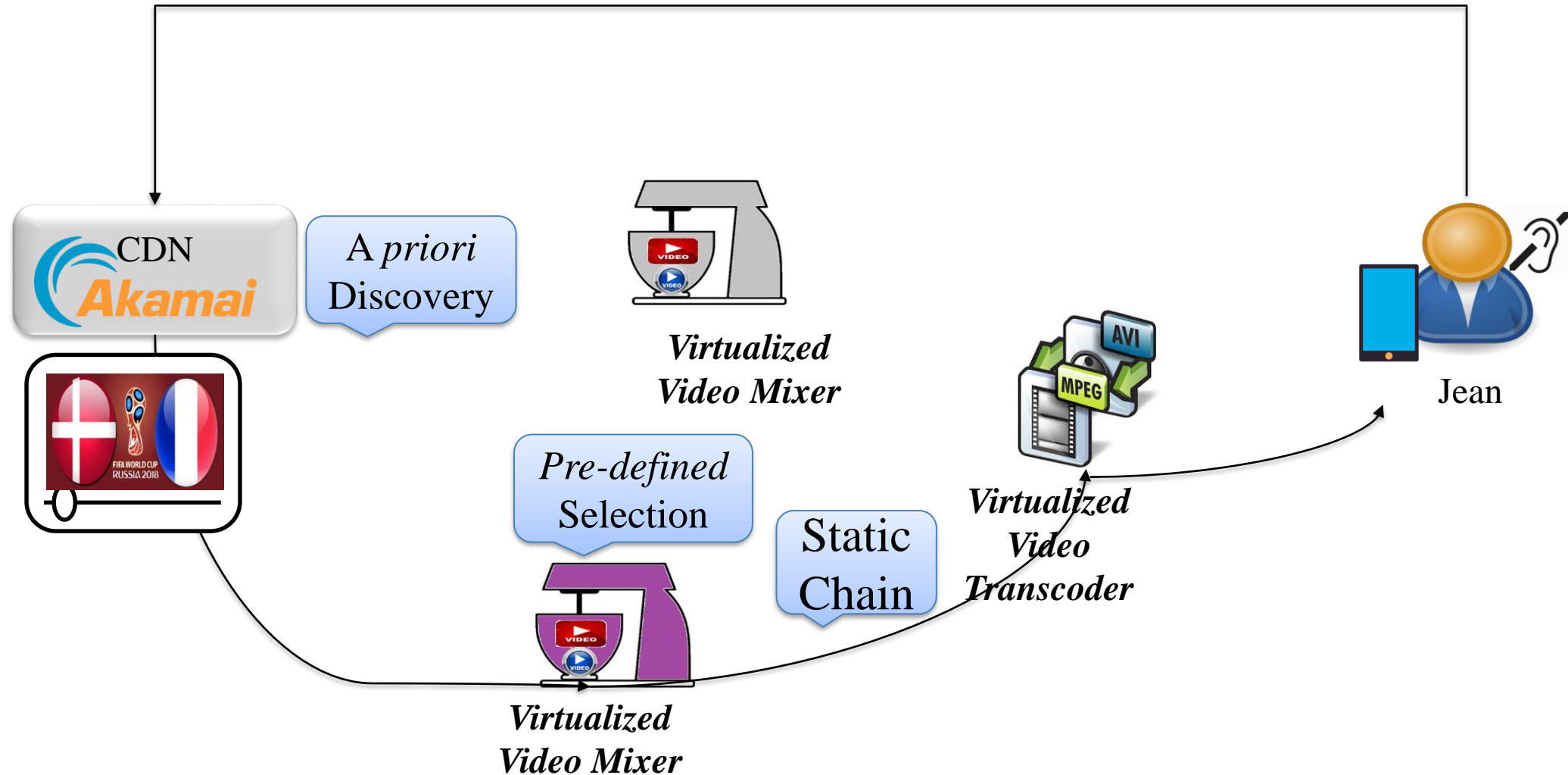
Request



This can lead to more agile networks, with significant Opex and Capex savings

Motivating use case

World Cup match Commentary + Sign language video+ MPEG



Problem Statement

- Lack of common understanding for VNF description due to:
 - Different providers, different technologies
 - Implicit knowledge (diverse interpretations)
- Heterogeneity among different VNF Providers
 - Existing descriptors and repositories are properties for the providers and for the domain
 - Human intervention
- Manual discovery process:
 - Time consuming
 - Possible Inefficient results (limited VNF candidates)

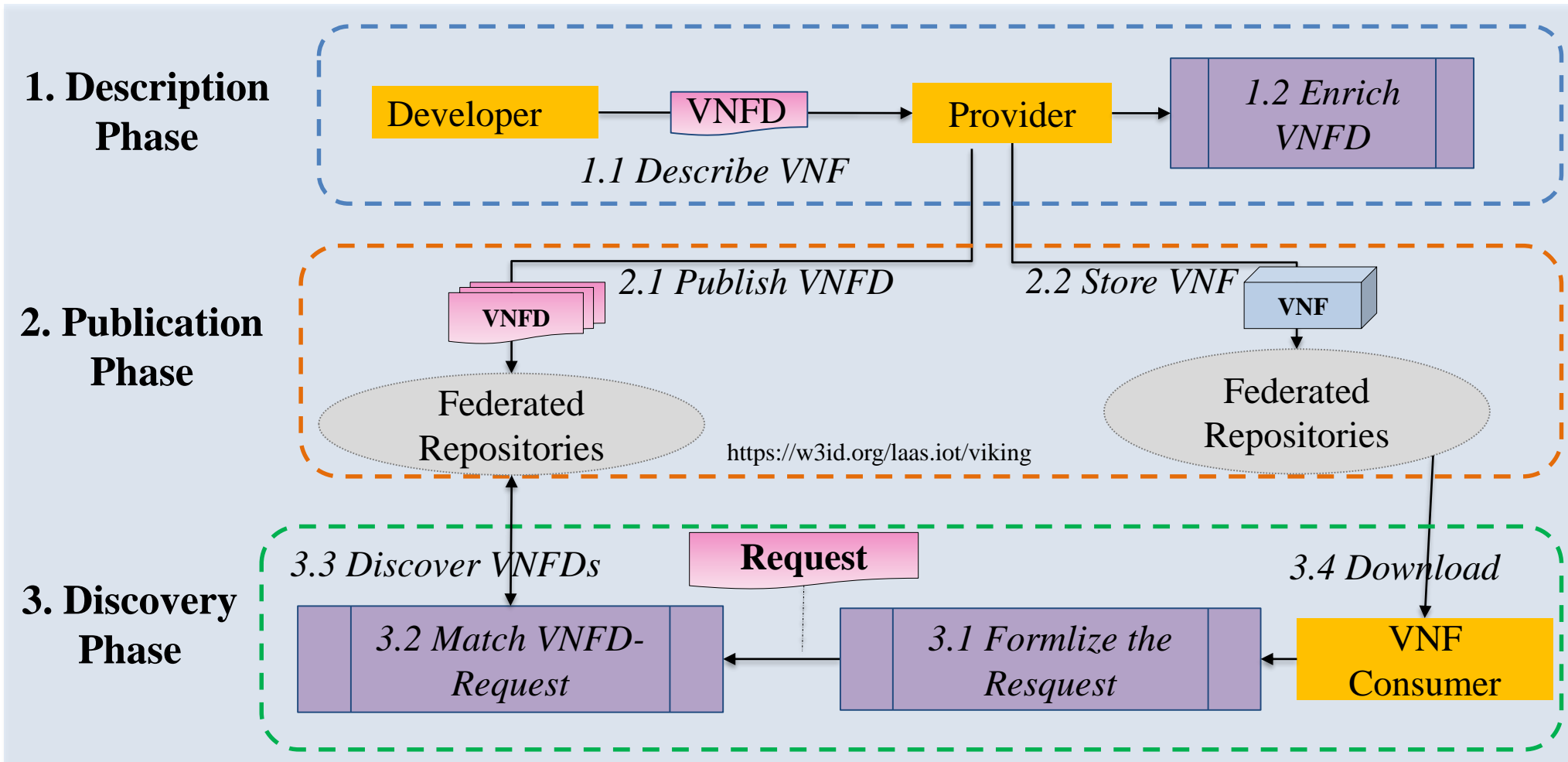
Associated Requirements

- A **generic and unified VNF description model** for discovery purpose:
 - Covers different providers' terminology,
 - Supports functional and non-functional properties.
- **Federated repositories** where VNFs and their related descriptors can be aggregated and exposed to the CDN providers.
- A **unified and efficient discovery procedure** that implements a relevant, precise and rapid matchmaking between the offered and the required VNFs.

- Define Virtualized Network Function IoN ontoloGy (**VIKING**) as a semantic representation of the VNF
 - Supports the VNF's lifecycle (Describe, Publish, Discover, Deploy/Configure and execute)
- Propose a tool that:
 - Assists the developer to describe the VNFs (consistency checking)
 - Assists the provider to publish it
 - Rewrites the consumer request
 - Automates VNF discovery thanks to VIKING

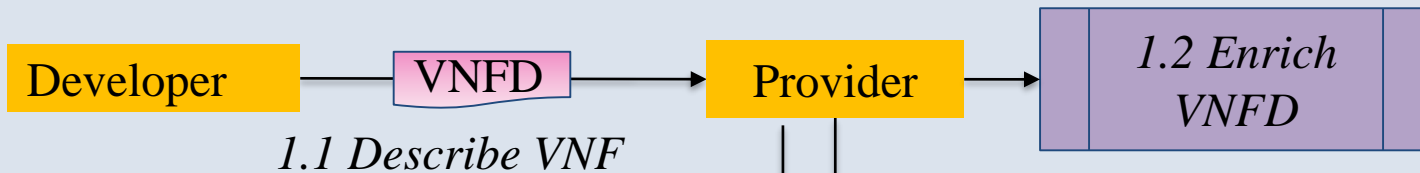
- Context
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An overview of the system architecture



An overview of the system architecture

1. Description Phase



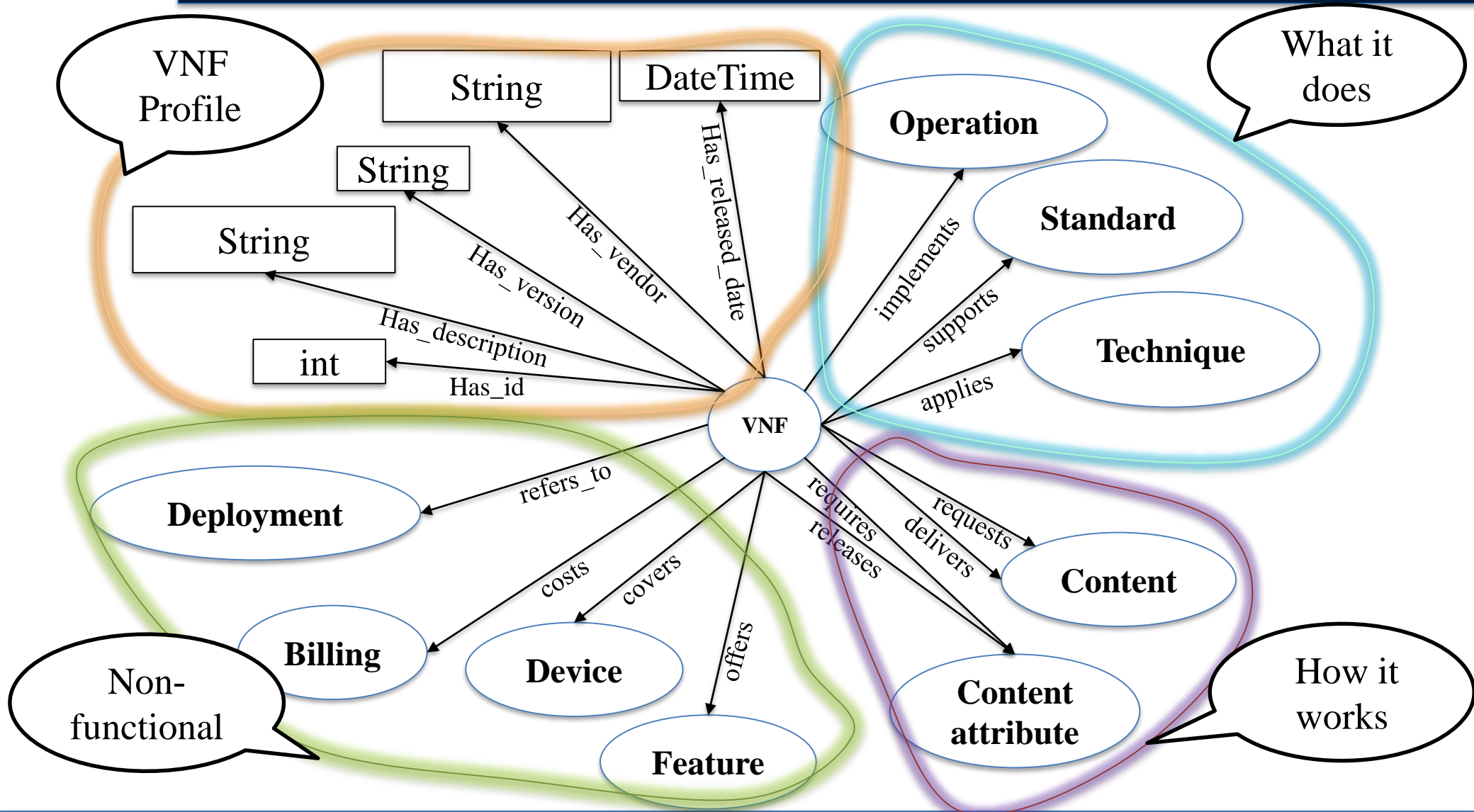
2. Publication Phase



The VNF Description model :

- Efficiently describe VNFs through well-defined descriptions aligned to VIKING Specification
- Describe Functional, Non-Functional requirements and Deployment information
- Publish VNFs and the descriptions into accessible VNF stores

VIKING Attributes and Relations



VIKING Inference rules

- ✓ Consistency checking
- ✓ Reasoning for VNF description



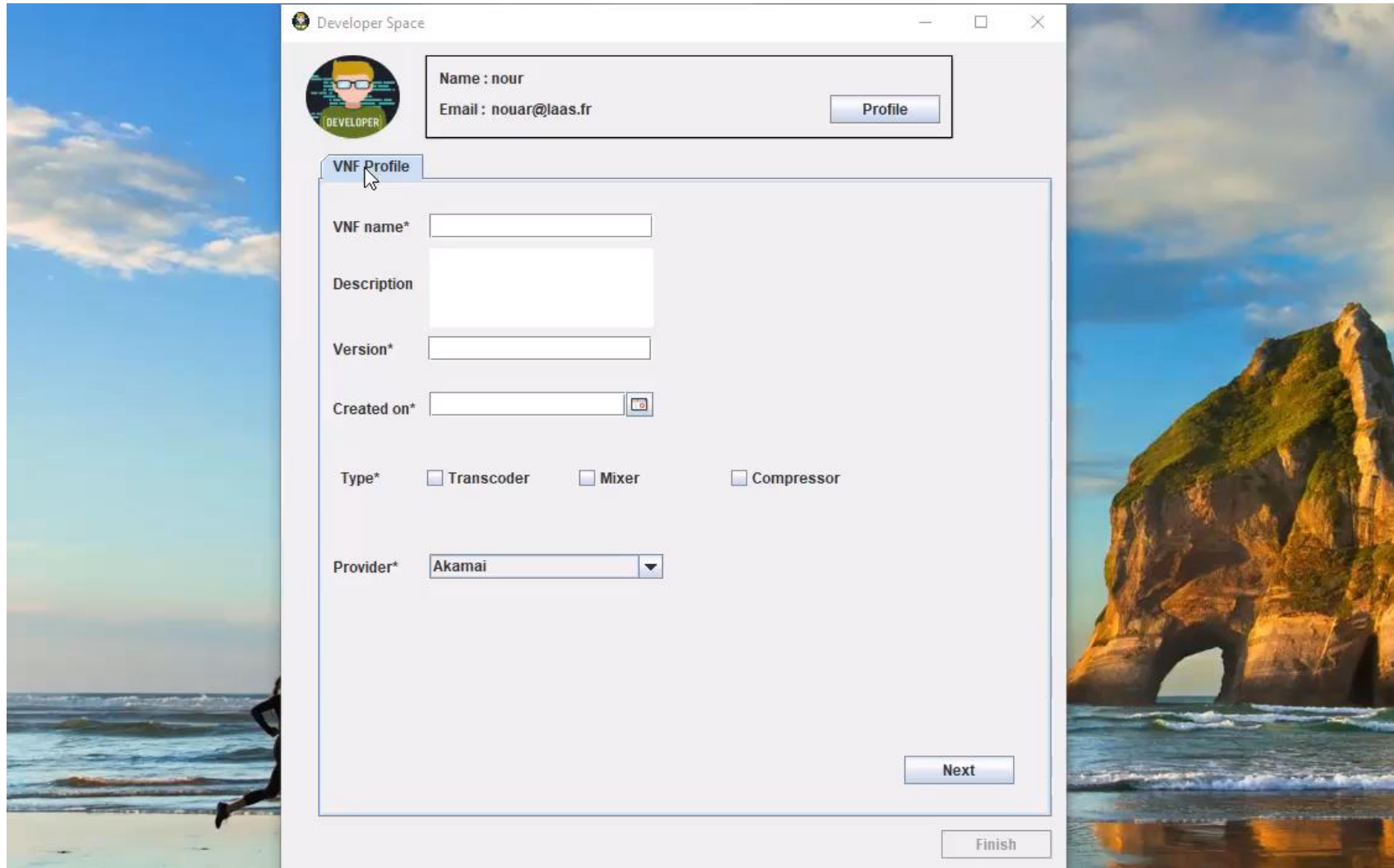
An error occurred during reasoning



InconsistentOntologyException: Cannot do reasoning with inconsistent ontologies!

Reason for inconsistency: Individual http://www.semanticweb.org/pc/ontologies/2018/3/VIKING#pictures_mixing is forced to belong to class http://www.semanticweb.org/pc/ontologies/2018/3/VIKING#Transcoding_opertaion and its complement

OK



Developer Space


Name : nour
Email : nouar@laas.fr [Profile](#)

VNF Profile

VNF name*

Description

Version*

Created on* 

Type* Transcoder Mixer Compressor

Provider*

[Next](#)

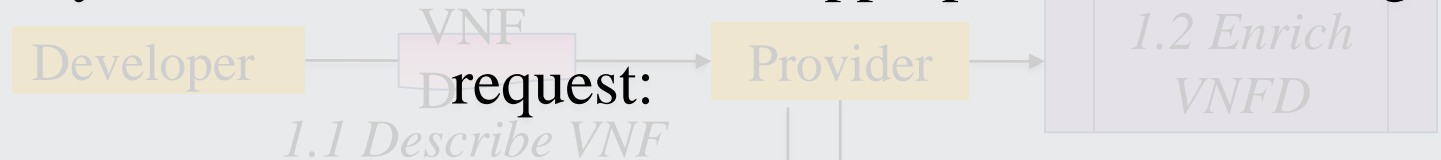
[Finish](#)

- Context
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An overview of the VNF discovery framework

The VNF Discovery Process aims to locate the appropriate VNF for a given

1. Description Phase



(1) Easily and dynamically discover VNFs on demand

2. Publication Phase

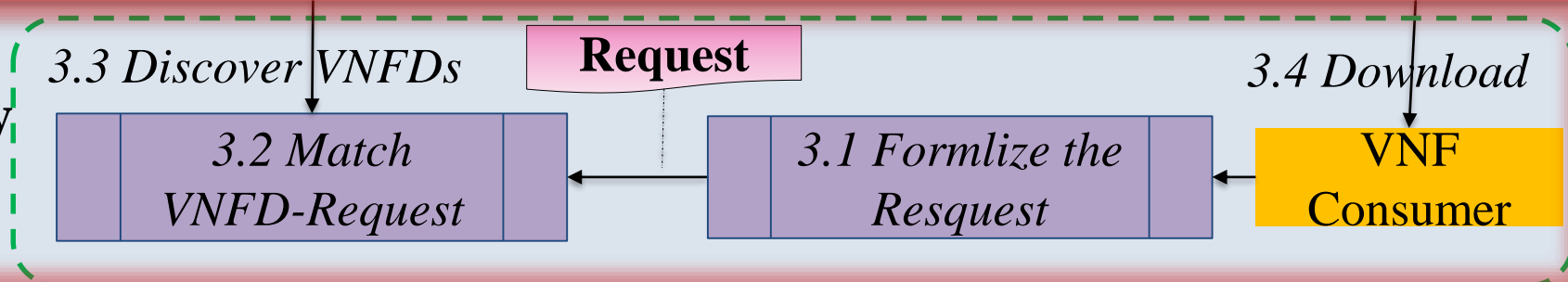


(2) Propose a novel approach to enhance VNF discovery

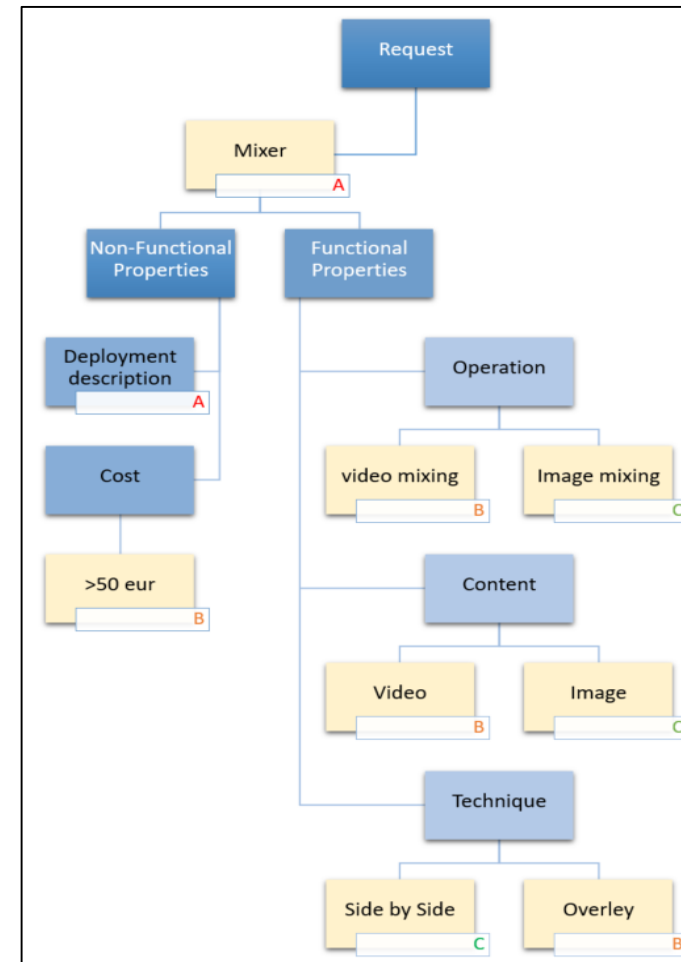
(3) Develop an efficient semantic VNF matchmaking

<https://w3id.org/laas.iot/viking>

3. Discovery Phase



- Formulate a user Request
 - Request description includes both functional and non-functional requirements
- Specify a Global Preferences for Functional set, Non-Functional set and Properties set.
- Set Properties Preferences
 - Be able to indicate the compulsory requirements
 - Be able to designate the negotiable requirements



VNF Discovery Demonstration

The screenshot shows a web application window titled "VNF Discovery Demonstration". At the top, there are three radio buttons for "VNF Type": "Transcoder" (selected), "Mixer", and "Compressor". To the right of these buttons are two buttons: "search" and "Personalized Request". Below the buttons is a table with three columns: "N°", "VNF name", and "Type". The table contains 36 rows, all of which are "Transcoder" type VNFs with names ranging from Vtranscoder197 to Vtranscoder99. The application is displayed over a background image of a person running on a beach at sunset, with a large rock formation in the distance.

N°	VNF name	Type
1	Vtranscoder197	Transcoder
2	Vtranscoder198	Transcoder
3	Vtranscoder199	Transcoder
4	Vtranscoder193	Transcoder
5	Vtranscoder194	Transcoder
6	Vtranscoder195	Transcoder
7	Vtranscoder196	Transcoder
8	Vtranscoder190	Transcoder
9	Vtranscoder191	Transcoder
10	Vtranscoder192	Transcoder
11	Vtranscoder175	Transcoder
12	Vtranscoder176	Transcoder
13	Vtranscoder177	Transcoder
14	Vtranscoder178	Transcoder
15	Vtranscoder171	Transcoder
16	Vtranscoder172	Transcoder
17	Vtranscoder173	Transcoder
18	Vtranscoder174	Transcoder
19	Vtranscoder170	Transcoder
20	Vtranscoder168	Transcoder
21	Vtranscoder169	Transcoder
22	Vtranscoder186	Transcoder
23	Vtranscoder187	Transcoder
24	Vtranscoder188	Transcoder
25	Vtranscoder189	Transcoder
26	Vtranscoder182	Transcoder
27	Vtranscoder183	Transcoder
28	Vtranscoder184	Transcoder
29	Vtranscoder185	Transcoder
30	Vtranscoder180	Transcoder
31	Vtranscoder181	Transcoder
32	Vtranscoder179	Transcoder
33	Vtranscoder96	Transcoder
34	Vtranscoder97	Transcoder
35	Vtranscoder98	Transcoder
36	Vtranscoder99	Transcoder

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- To validate the proposed Algorithm:
 - We generate a Test Collection for each VNF type of 200 sample,
 - We variate the VNFDs information in each set
 - Check the coherence
 - Check the robustness

- VNFs Generator

Generator

VNF Type

Transcoder Compressor Mixer

Descriptors number:

Descriptor Characteristics

Manner: Random Customized

Functional Properties

Same Different

Operations Techniques Standards

Content Content Attributes Inputs/Outputs

Non-Functional Properties

Same Different

Devices Features Resource Requirements

Generate

Tr_Virtual_Transcoder7286

- Tr_Virtual_Transcoder7303
- Tr_Virtual_Transcoder7342
- Tr_Virtual_Transcoder7411
- Tr_Virtual_Transcoder7450
- Tr_Virtual_Transcoder7457
- Tr_Virtual_Transcoder7588
- Tr_Virtual_Transcoder7714
- Tr_Virtual_Transcoder7728
- Tr_Virtual_Transcoder7788
- Tr_Virtual_Transcoder7854
- Tr_Virtual_Transcoder7927
- Tr_Virtual_Transcoder7933
- Tr_Virtual_Transcoder7954
- Tr_Virtual_Transcoder8040
- Tr_Virtual_Transcoder8050
- Tr_Virtual_Transcoder8087
- Tr_Virtual_Transcoder8122
- Tr_Virtual_Transcoder8170
- Tr_Virtual_Transcoder8183
- Tr_Virtual_Transcoder8239
- Tr_Virtual_Transcoder8269
- Tr_Virtual_Transcoder837
- Tr_Virtual_Transcoder8460
- Tr_Virtual_Transcoder8526
- Tr_Virtual_Transcoder853
- Tr_Virtual_Transcoder8532
- Tr_Virtual_Transcoder8554
- Tr_Virtual_Transcoder857

Property assertions: Tr_Virtual_Transcoder7286

Object property assertions

- requires_VideoResolution 4k
- requires_VideoFormat AVI
- supplies_VideoFormat AVI
- requires_VideoResolution 360p
- supplies_VideoFormat TS
- supplies_AudioResolution 720p
- requires_VideoFormat TS
- requires_VideoFormat PS
- supplies_VideoFormat MPG
- requests Audio
- applies spatial_adaptation
- supplies_VideoFormat PS
- requires_AudioResolution 480p
- requires_AudioResolution 240p
- requests Video
- supplies_VideoFormat MP4
- requires_VideoFormat MP4
- implements Transmuxing
- supplies_AudioResolution 480p
- supplies_AudioResolution 240p
- requires_VideoFormat MPG
- implements Transcoding

N°	VNF Name	Final Score	FP matching	NFP matchi...
0	Tr_Virtual_Transcoder3874	78.04 %	83.0%	67.0%
1	Tr_Virtual_Transcoder5543	77.45 %	75.0%	83.0%
2	Tr_Virtual_Transcoder3177	72.25 %	75.0%	67.0%
3	Tr_Virtual_Transcoder8554	67.25 %	75.0%	50.0%
4	Tr_Virtual_Transcoder8823	67.06 %	83.0%	33.0%
5	Tr_Virtual_Transcoder5631	66.08 %	58.0%	83.0%
6	Tr_Virtual_Transcoder7411	66.08 %	50.0%	100.0%
7	Tr_Virtual_Transcoder7058	62.06 %	83.0%	17.0%
8	Tr_Virtual_Transcoder9500	61.47 %	75.0%	33.0%
9	Tr_Virtual_Transcoder7588	61.47 %	75.0%	33.0%
10	Tr_Virtual_Transcoder4341	61.47 %	75.0%	33.0%
11	Tr_Virtual_Transcoder4148	61.27 %	75.0%	33.0%
12	Tr_Virtual_Transcoder3261	61.08 %	67.0%	50.0%
13	Tr_Virtual_Transcoder7854	61.08 %	50.0%	83.0%
14	Tr_Virtual_Transcoder6413	60.88 %	67.0%	50.0%
15	Tr_Virtual_Transcoder4606	60.88 %	67.0%	50.0%
16	Tr_Virtual_Transcoder4446	60.69 %	50.0%	83.0%
17	Tr_Virtual_Transcoder6087	56.47 %	75.0%	17.0%
18	Tr_Virtual_Transcoder8916	56.47 %	75.0%	17.0%
19	Tr_Virtual_Transcoder7342	56.27 %	58.0%	50.0%
20	Tr_Virtual_Transcoder9249	56.08 %	67.0%	33.0%
21	Tr_Virtual_Transcoder3686	55.88 %	67.0%	33.0%
22	Tr_Virtual_Transcoder2878	55.88 %	58.0%	50.0%
23	Tr_Virtual_Transcoder5183	55.69 %	67.0%	33.0%
24	Tr_Virtual_Transcoder8087	55.49 %	58.0%	50.0%
25	Tr_Virtual_Transcoder9273	55.29 %	58.0%	50.0%
26	Tr_Virtual_Transcoder7450	55.29 %	58.0%	50.0%
27	Tr_Virtual_Transcoder6637	55.29 %	50.0%	67.0%
28	Tr_Virtual_Transcoder1756	55.29 %	42.0%	83.0%
29	Tr_Virtual_Transcoder6339	55.1 %	42.0%	83.0%
30	Tr_Virtual_Transcoder1599	54.9 %	42.0%	83.0%

Request \ VNF		Global Preference	VT_9500	VT_7588	VT_4341	
Operations	Transcoding(B)	60%	✓	✗	✓	
	Transmuxing (B)		✗	✓	✗	
Contents	Video		✓	✓	✓	
	Audio		✓	✓	✓	
	Image		✓	✓	✓	
Techniques	Spatial adaptation		✓	✓	✓	
	Quality adaptation (B)		✗	✗	✗	
Standards	H.261		✓	✓	✓	
	MPEG-1		✓	✓	✓	
	MPEG-2 (C)		✓	✗	✗	
	MPEG-4(C)		✗	✓	✓	
	HEVC		✓	✓	✓	
Devices	Xbox		30%	✓	✓	✓
	Playstation(C)			✗	✗	✗
	Android			✓	✓	✓
Features	Rotate(C)			✗	✗	✗
	Deinterlacing(C)			✗	✗	✗
	Scaling(C)			✗	✗	✗
Properties Preference			10%			
Rank				8	9	10

N°	VNF Name	Final Score	FP matching	NFP matchi...
0	Tr_Virtual_Transcoder3874	79.32 %	83.0%	67.0%
1	Tr_Virtual_Transcoder5543	78.41 %	75.0%	83.0%
2	Tr_Virtual_Transcoder3177	73.18 %	75.0%	67.0%
3	Tr_Virtual_Transcoder8554	68.18 %	75.0%	50.0%
4	Tr_Virtual_Transcoder8823	67.95 %	83.0%	33.0%
5	Tr_Virtual_Transcoder7411	67.05 %	50.0%	100.0%
6	Tr_Virtual_Transcoder5631	66.82 %	58.0%	83.0%
7	Tr_Virtual_Transcoder7058	62.95 %	83.0%	17.0%
8	Tr_Virtual_Transcoder7588	62.5 %	75.0%	33.0%
9	Tr_Virtual_Transcoder9500	62.27 %	75.0%	33.0%
10	Tr_Virtual_Transcoder4148	62.27 %	75.0%	33.0%
11	Tr_Virtual_Transcoder4341	62.27 %	75.0%	33.0%
12	Tr_Virtual_Transcoder3261	62.05 %	67.0%	50.0%
13	Tr_Virtual_Transcoder7854	61.82 %	50.0%	83.0%
14	Tr_Virtual_Transcoder4606	61.82 %	67.0%	50.0%
15	Tr_Virtual_Transcoder6413	61.59 %	67.0%	50.0%
16	Tr_Virtual_Transcoder4446	61.36 %	50.0%	83.0%
17	Tr_Virtual_Transcoder8916	57.5 %	75.0%	17.0%
18	Tr_Virtual_Transcoder6087	57.27 %	75.0%	17.0%
19	Tr_Virtual_Transcoder7342	57.05 %	58.0%	50.0%
20	Tr_Virtual_Transcoder9249	57.05 %	67.0%	33.0%
21	Tr_Virtual_Transcoder3686	56.82 %	67.0%	33.0%
22	Tr_Virtual_Transcoder2878	56.59 %	58.0%	50.0%
23	Tr_Virtual_Transcoder5183	56.59 %	67.0%	33.0%
24	Tr_Virtual_Transcoder1756	56.14 %	42.0%	83.0%
25	Tr_Virtual_Transcoder6637	56.14 %	50.0%	67.0%
26	Tr_Virtual_Transcoder9273	56.14 %	58.0%	50.0%
27	Tr_Virtual_Transcoder8087	56.14 %	58.0%	50.0%
28	Tr_Virtual_Transcoder6339	55.91 %	42.0%	83.0%
29	Tr_Virtual_Transcoder7450	55.91 %	58.0%	50.0%

Request \ VNF		Global Preference	VT_9500	VT_7588	VT_4341
Operations	Transcoding(C)	60%	✓	✗	✓
	Transmuxing (B)		✗	✓	✗
Contents	Video		✓	✓	✓
	Audio		✓	✓	✓
	Image		✓	✓	✓
Techniques	Spatial adaptation		✓	✓	✓
	Quality adaptation (B)		✗	✗	✗
Standards	H.261		✓	✓	✓
	MPEG-1		✓	✓	✓
	MPEG-2 (C)		✓	✗	✗
	MPEG-4(C)		✗	✓	✓
	HEVC	✓	✓	✓	
Devices	Xbox	30%	✓	✓	✓
	Playstation(C)		✗	✗	✗
	Android		✓	✓	✓
Features	Rotate(C)		✗	✗	✗
	Deinterlacing(C)		✗	✗	✗
	Scaling(C)		✗	✗	✗
Properties Preference		10%			
Rank			9	8	11

N°	VNF Name	Final Score	FP matching	NFP matchi...
0	Tr_Virtual_Transcoder3874	78.04 %	83.0%	67.0%
1	Tr_Virtual_Transcoder5543	77.45 %	75.0%	83.0%
2	Tr_Virtual_Transcoder3177	72.25 %	75.0%	67.0%
3	Tr_Virtual_Transcoder8554	67.25 %	75.0%	50.0%
4	Tr_Virtual_Transcoder8823	67.06 %	83.0%	33.0%
5	Tr_Virtual_Transcoder5631	66.08 %	58.0%	83.0%
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12	Tr_Virtual_Transcoder3261	61.08 %	67.0%	50.0%
13	Tr_Virtual_Transcoder7854	61.08 %	50.0%	83.0%
14	Tr_Virtual_Transcoder6413	60.88 %	67.0%	50.0%
15	Tr_Virtual_Transcoder4606	60.88 %	67.0%	50.0%
16	Tr_Virtual_Transcoder4446	60.69 %	50.0%	83.0%
17	Tr_Virtual_Transcoder6087	56.47 %	75.0%	17.0%
18	Tr_Virtual_Transcoder8916	56.47 %	75.0%	17.0%
19	Tr_Virtual_Transcoder7342	56.27 %	58.0%	50.0%
20	Tr_Virtual_Transcoder9249	56.08 %	67.0%	33.0%
21	Tr_Virtual_Transcoder3686	55.88 %	67.0%	33.0%
22	Tr_Virtual_Transcoder2878	55.88 %	58.0%	50.0%
23	Tr_Virtual_Transcoder5183	55.69 %	67.0%	33.0%
24	Tr_Virtual_Transcoder8087	55.49 %	58.0%	50.0%
25	Tr_Virtual_Transcoder9273	55.29 %	58.0%	50.0%
26	Tr_Virtual_Transcoder7450	55.29 %	58.0%	50.0%
27	Tr_Virtual_Transcoder6637	55.29 %	50.0%	67.0%
28	Tr_Virtual_Transcoder1756	55.29 %	42.0%	83.0%
29	Tr_Virtual_Transcoder6339	55.1 %	42.0%	83.0%

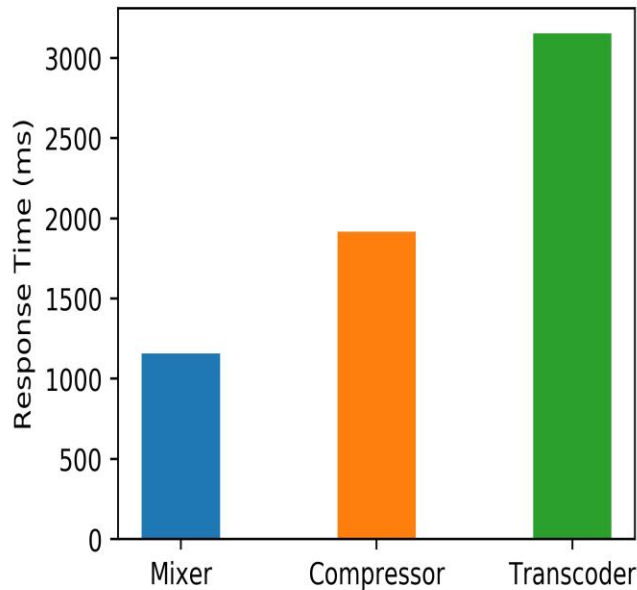
Set's global Preferences:

FP=60%, NFP=30%, Prefs=10%

N°	VNF Name	Final Score	FP matching	NFP matchi...
0	Tr_Virtual_Transcoder7411	81.08 %	50.0%	100.0%
1	Tr_Virtual_Transcoder5543	79.95 %	75.0%	83.0%
2	Tr_Virtual_Transcoder5631	73.58 %	58.0%	83.0%
3	Tr_Virtual_Transcoder3874	73.04 %	83.0%	67.0%
4	Tr_Virtual_Transcoder7854	71.08 %	50.0%	83.0%
5	Tr_Virtual_Transcoder4446	70.69 %	50.0%	83.0%
6	Tr_Virtual_Transcoder3177	69.75 %	75.0%	67.0%
7	Tr_Virtual_Transcoder1756	67.79 %	42.0%	83.0%
8	Tr_Virtual_Transcoder6339	67.6 %	42.0%	83.0%
9	Tr_Virtual_Transcoder1598	67.4 %	42.0%	83.0%
10	Tr_Virtual_Transcoder6462	67.21 %	42.0%	83.0%
11	Tr_Virtual_Transcoder8170	61.23 %	25.0%	83.0%
12	Tr_Virtual_Transcoder6637	60.29 %	50.0%	67.0%
13	Tr_Virtual_Transcoder8554	59.75 %	75.0%	50.0%
14	Tr_Virtual_Transcoder2886	57.4 %	42.0%	67.0%
15	Tr_Virtual_Transcoder8794	57.4 %	42.0%	67.0%
16	Tr_Virtual_Transcoder4600	57.21 %	42.0%	67.0%
17	Tr_Virtual_Transcoder3261	56.08 %	67.0%	50.0%
18	Tr_Virtual_Transcoder6413	55.88 %	67.0%	50.0%
19	Tr_Virtual_Transcoder4606	55.88 %	67.0%	50.0%
20	Tr_Virtual_Transcoder6482	54.12 %	33.0%	67.0%
21	Tr_Virtual_Transcoder3179	54.12 %	33.0%	67.0%
22	Tr_Virtual_Transcoder7342	53.77 %	58.0%	50.0%
23	Tr_Virtual_Transcoder2878	53.38 %	58.0%	50.0%
24	Tr_Virtual_Transcoder8087	52.99 %	58.0%	50.0%
25	Tr_Virtual_Transcoder9273	52.79 %	58.0%	50.0%
26	Tr_Virtual_Transcoder7450	52.79 %	58.0%	50.0%
27	Tr_Virtual_Transcoder8823	52.06 %	83.0%	33.0%
28	Tr_Virtual_Transcoder8269	50.83 %	25.0%	67.0%
29	Tr_Virtual_Transcoder2001	50.69 %	50.0%	50.0%

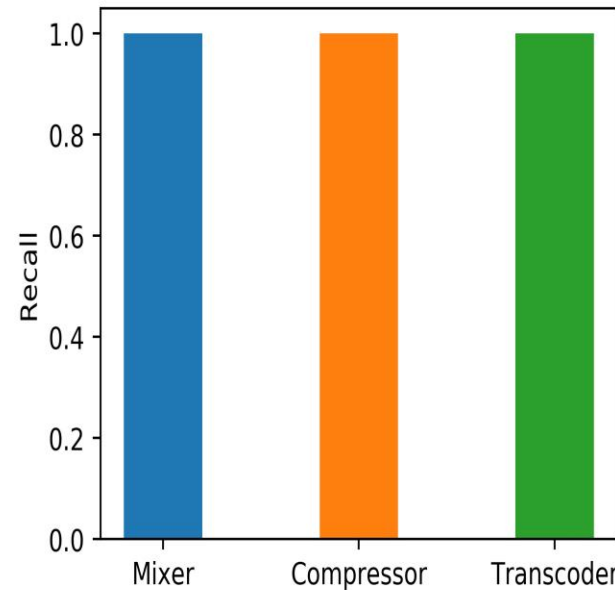
Set's global Preferences:

FP=30%, NFP=60%, Prefs=10%



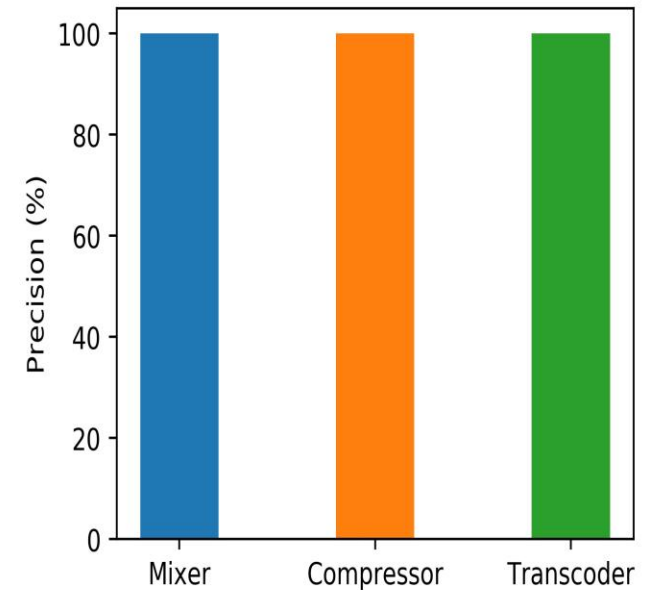
Response time

is the time duration between VNF users sending a request and receiving the corresponding response.



Recall

is defined as the fraction of relevant VNFs that are retrieved to the user request.



Precision

is defined as the fraction of retrieved VNFs that are relevant to the user request.

- Context
- Motivating use case and requirement
- Proposed System Architecture
 - A novel VNF description model/language
 - A novel VNF Discovery approach
- Validation & Evaluation
- **Lessons learned & Next steps**

- **Lessons learned**

- Proposal of a novel VNF Description Model that helps each of VNF Developer and VNF Provider to describe their VNF.
- Proposal of a novel VNF Discovery Approach that helps the user to get the most appropriate VNFs match his request and his preferences.

- **Next steps**

- Dynamic Service Composition and Chaining, Provides the adaptation of the dynamic changes of the users needs

Thank you for your attention

Questions ?