ENI ISG - PoC Proposal

1 PoC Project Details

1.1 PoC Project

PoC Number (assigned by ETSI):

PoC Project Name: Intelligent Energy Management of DC

PoC Project Host: China Telecom

Short Description: This PoC will provide viable solutions and methodologies for the energy management of DCs (Data Centre) through the use of a set of AI algorithms based on DC dynamic environment data, focusing on techniques such as Mechine Leanrning and Data Mining. DC energy management policies will be based on general and specific AI models to help DCs achieve a better PUE (Power Usage Effectiveness) and reduce OPEX for telecom operators.

The proposed concept will address technical aspects related to the following ENI Work Items:

1. Use Cases: this PoC will comply with a set of use cases and senarios specified in ENI 001 (WI RGS/ENI-0014). New use case may be proposed for ENI 001.

2. Requirements: this PoC will comply with a set of requirements specified in ENI 002 (WI RGS/ENI-0015), which will form a basis for DC energy management, including target KPIs under different operator applications. New requirements may be proposed for ENI 002 (WI RGS/ENI-0015).

3. Categorization: this PoC will comply with the categorization model studied and proposed in GR ENI 007 "Definition of Networked Intelligence Categorization" i.e. giving the DC profiles in terms of current dymamic environmental parameters, a DC can be categorised according to GR ENI 007, by making the DC classification more accurate.

4. Terminology: this PoC will comply with the definition and abbreviations provided in ENI 004 (WI RGR/ENI-0018).

5. Data Mechanism: this PoC will comply with the data classification defined in (WI DGR/ENI-0017) ENI 009 "Definition of data processing mechanisms".

The proposed PoC intends to deploy, test and validate the AI-based methologies framework as those proposed by the above mentioned ENI WIs. More specifically, this PoC plans to achieve energy saving for DCs by using a transferable set of policies. This will also enable DCs classified with the same categories to obtain similar results, hence making this PoC a general reference for similar senarios.

1.2 PoC Team Members

Table 1.1

	Organization name	ISG ENI participant (yes/no)	Contact (Email)	PoC Point of Contact (see note 1)	Role (see note 2)	PoC Components
1	China Telecom	Yes	Yu Zeng (zengyu@chinatelecom.cn) Yannan Bai (baiyn6@chinatelecom.cn) Dan Xu xudan6@chinatelecom.cn Feng Wang wangfeng6@chinatelecom.cn	X	Service Provider	- Use Cases definition - PoC development - PoC documentation - PoC demos
2	Intel	Yes	Haining Wang(haining.wang@intel.com) Kuo Liao(kuo.liao@intel.com) Tong Zhang(tong2.zhang@intel.com) Ribo Sun (ribo.sun@intel.com)		Manufacturer	-Help with implementation of algorithm, testbed setup and demo
3	Asia Info	Yes	Lilei Wang(wangll9@asiainfo.com)		Manufacturer	- Help with Policy and tools
4	Samsung	Yes	yue2.wang@samsung.com		Manufacturer	- Help with implementation of algorithm, data processing and AI algorithms
5	Huawei	Yes	Paolo.gemma@huawei.com		Manufacturer	- Help with implementation of algorithm

All the PoC Team members listed above declare that the information in this proposal is conformant to their plans at this date and commit to inform ETSI timely in case of changes in the PoC Team, scope or timeline.

1.3 PoC Project Scope

1.3.1 PoC Goals

The detailed goals include:

 PoC Project Goal #1: DC profile analysis. Demonstrate the use of AI-based methods to analyze energy related data, e.g. DC dynamic environment and IT workload data etc.

 PoC Project Goal #2: Policy-based DC Energy Management. Demonstrate the use of AI algorithms to enable policy-based energy management.

1.3.2 PoC Topics

Table 1.2 contains the list of contributions that may be expected against the draft WIs active during the lifetime of the current PoC.

Table 1.2

PoC Topic Description	Document Number (Related WI)	Expected Contribution	Target Date
New use case for Intelligent Energy Management of DC	Use Cases: refer to ENI 001 (WI RGS/ENI-014 or a subsequent version)	Contribute to use case or new ues case in a open work item. (e.g. hardware based, software based, cooling policy based) .	ENI#20
New requirements for Intelligent Energy Management of DC	Requirements: refer to ENI 002 (WI RGS/ENI-015 or a subsequent version)	Propose new requirements in contributions on DC energy management.(e.g. transferable DC requirements for different operation modes)	ENI#20
Proposal ofexamples of Data Mechanism of Intelligent Energy Management of DC	Data Mechanism: refer to ENI 009 (WI DGR/ENI-0017 or a subsequent version)	Provide contributions to data mechanism related to DC energy management. (e.g. data sheet specifications for certain type of DC)	ENI#20
Update the Terminology WI on Intelligent Energy Management of DC	Terminology: refer to ENI 004 (RGR/ENI-0018 or a subsequent version)	Update definitions in Terminology WI. (e.g. DC related definition and abbreviations)	ENI#20

1.4 PoC Project Stages/Milestones

This table reflects the milestones planning done for this PoC in terms of roadmap for PoC submission, contributions, test plan, demos, and reports. It should be noted that dates pointed out are merely indicative, i.e. they are valid just an ideal sequence plan. However, at this moment, they may be changed during PoC roll out due to current covid-19 situation.

Table 1.4

PoC Milestone	Stages/Milestone description	Target Date	Additional Info
P.S	PoC project submission	03/2020	Presentation during #ENI 13
P.TP.1	PoC Test Plan 1	12/2020	Initial testbed up and running
P.D1	PoC Demo 1	03/2021	Webinar demo at the ENI#18 plenary meeting
P.D2	PoC Demo 2	06/2021	Demo at shanghai MWC 2021
P.D3	PoC Demo 3	TBD	Demo at Intel AI summit
P.C1	PoC Expected Contribution 1	07/2021	Contributions to ENI use case
P.C2	PoC Expected Contribution 2	07/2021	Contributions to ENI requirement
P.C3	PoC Expected Contribution 4	09/2021	Contributions to ENI terminology
P.C4	PoC Expected Contribution 5	09/2021	Contributions to ENI data mechanism
P.R	PoC Report	09/2021	PoC-Project-End Feedback
P.E	PoC Project End	12/2021	Presented to ISG ENI for information
Note; The deadlines may subject to change according to covid-19 situation.			

2 PoC Technical Details

2.1 PoC Overview

With the arrival of 5G, the network infrastructure is facing a new era. Besides the bandwidth and flexibility 5G will bring to the industry, an increase of energy consumption of related network components is also expected at a scale never seen before. The power comsuption of base stations, cloud DCs and MEC （Mobile Edge Computing）take most of the energy bill of telecom operators. The DCs are taking more important roles with the transformation of the network, and the expansions of DCs make it crutial to manage energy cost in a more intelligent way. In terms of improving power efficiency, AI can be used to help all aspects of the energy management of DCs, such as dynamic environment analysis, data collecting, ups failure prediction, or active cooling. Its important to obtain DC profiles by using related data, and set up related AI model that can match the cooling requirements and reduce the redundancy of cooling power. Various AI methodologies and algorisms can be validated according to real scenarios. The PoC team is eager to work with Intel, Asiainfo and potential partners to form a closed loop in the energy management cycle.

Traditionally, DCs energy management was provided by KPIs that were derived from user SLAs, that is, the default expensive roll out often taking more priority than energy saving. This often results in a cooling redundant system to ensure the servers are not overheating. By pursuing environmental protecting laws as well as reducing greenhouse gas emission, the energy management of DCs is changing to make the DC less redundant in terms of cooling power. With the growing number and size of DCs, its difficult for traditional manual tuned instruction based policy to achieve these desired targets. More precise AI based models can be used to provide further energy reduction for cooling optimisation e.g. to digitise the DC orofilest, to obtain dynamic environmental statistics, to make use of ML-training methods, to provide predictions of ups failure, to map energy cycle to server workload, to extract key factors affecting power consumption, or to make use of policy based cooling cycle adjustment, or others. The DCs can benefit both from general and specific AI models and further reducing telecom operator’s OPEX.

This PoC is proposed to demonstrate the use of AI in a DC dynamic environmental data context in order to performcategorization and DC requirements analysis. To achieve these goals, the following methodologies (see Figure 2 “Energy Trend and Pattern Analysis Exerience and AI Based” below) are used:

1. In order to set up the DC profile, related DC data needs to be obtained. For some DCs, this is provided as inherent native feature, while for some legacy DCs lack of some key data is expected. Thus, for the PoC Project Goal #1: DC profile analysis, some procedures can be taken to help to collect data. E.g. PUE can be calculated once cooling and IT power comsuptions value are available, the heat distribution of DCs and server racks can be calculated when

server status (CPU workload, Fan Speed, Memory usage, etc) are available, as some data is difficult to obtain directly. This shall demonstate PoC Project Goal #1: DC profile analysis.

2. Combined algorithms can be utilised to improve energy management efficiency. Computational Fluid Dynamic (CFD) can be used to analyse flow of cooling and heating air distribution. It's simple to lable hot point with the help of CFD, and with the help of ML/AI models, multiple algorisms can be identified to further help to reduce energy usage. E.g. CFD combined with server work load, can provide a basis for estimation of a future hot point and thus provide adequate cooling and steer towards where needed most. This shall demonstate PoC Project Goal #2: Policy-based DC Energy Management".
3. Policies based on DC profiles can be a potential benefit for DCs not equiped with additional probes that can provide more detailed dynamic environment data This will also help to built a set of policies and profilesof DC energy management.

Furthermore, this PoC is also proposed to demonstrate the use of AI algorithms to enable intelligent policy-based energy management, as indicated in Figure1, where:

- the first part is related with the data mining component used for analysis (PoC Goal #1) while,
- the second part is related with the model driven policy generation.(PoC Goal #2).

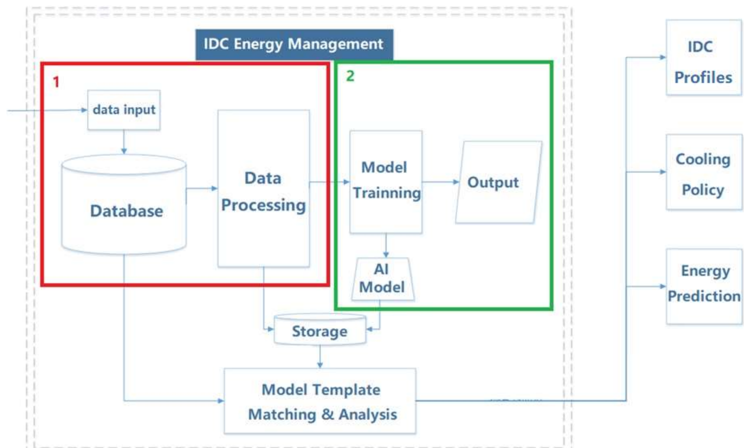

Figure 1: Data analysis and Intelligent policy-based energy management

In Figure 1, part 1 (in red) is responsible for data collection and processing, while part 2 (in green) is responsible for model training. The Figure also shows that part 1 and part 2 share a unified storage. Finally, energy saving policies can be generated as a consequence of the use of AI model matching and analysis.The output of an intelligent energy management provides policies that address IDC profiles, cooling and energy prediction.

2.2 PoC Architecture

2.2.1 Standalone scenario

The standalone scenario is a type of deployment where the PoC System perfornms by itself, as a standalone entity, the project goals above identified:

The PoC System Architecture of first scenario is shown in the left hand side of Figure 2. The diagram in Figure 2 outlines the architecture framework of this PoC. The DC is treated as Infrastructure when compared with the the ENI System Architecture, and the DC operation management system FB acts as an OSS-like system. The DC profile data can be seen as the input process of the ENI System Architecture. The data analysis and energy trend and pattern analysis FB can be considered as part of the analysis that is usualy performed by the ENI System Architecture. Energy saving policies FBs mimics the ouput recommendations of the ENI System Architecture. The north bound "data collecton" process indicate the first goal of this PoC, while south bound "Instruction, actuation, suggestion" process refer to the second goal of this PoC.

The following diagram shows how the framework of the PoC standalone scenario can be mapped to the ENI System reference architecture.

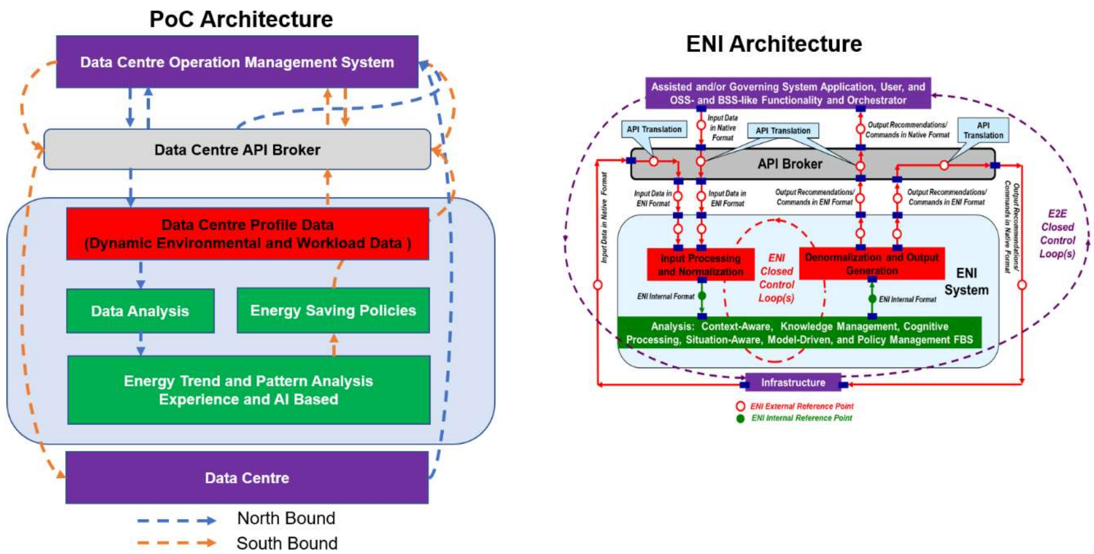

Figure 2: PoC architecture for the first scenario mapped to ENI reference architecture

2.2.2 Interaction scenario with the ENI System

This PoC also proposes the deployment of a second scenario, where the PoC System interacts with the ENI System as an assisted system, please see GS ENI 005, in order work in a network where the nodes are DCs that share a common data repository that contains knowledge constantly updated by the operation of each DC acting as a node.

To achieve this target, in a context where the ENI System performs part of functionalities, the reference point between different PoC systems and the ENI System need to be carefully implemented because there is a lot of information exchanged between them. Certain operations will need multiple connections and coordinations among related systems. Figure 3 depicts this interaction scenario:

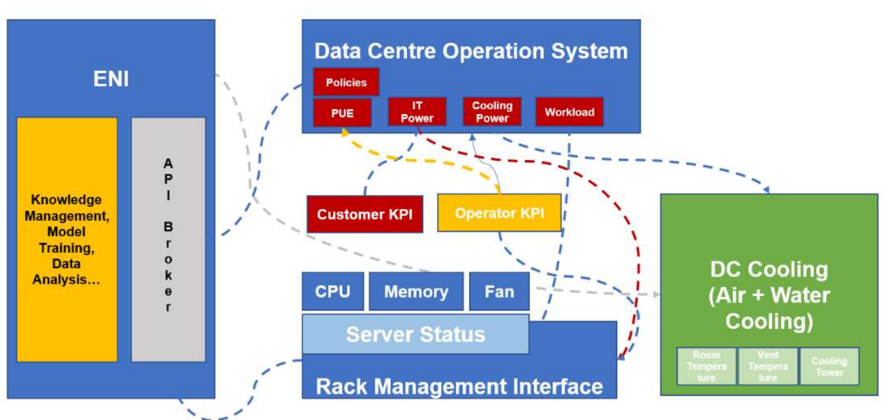

Figure 3: PoC System for the second scenario showing Interaction with ENI system

Figure 3 shows an interaction of internal and external reference points. In this scenario, different subsystems of DC energy management can be connected to the ENI system where DC data collected through the data acquisition process are provided to the ENI system. This enables the ENI System to analyse the data according to the requirements so that appropriate energy power saving policies are obtained and applied to the DC system.

2.3 PoC Success Criteria

Table 2 shows the behavior expected from a generic PoC system taking into account the data analysis performed either by the PoC System (standalone scenario) or by the ENI System feed with data coming from the PoC System (interactive scenario).

According to that data analysis, the DC may be classified as working in a certain mode / category level of operation. This PoC makes use of the category levels identified in GR ENI 007 and is shown in Table1, where:

- the columns demonstrate the level of DC energy management, from manual to fully automatic;
- the rows show the DC requirements for each level.

Table 2: Categories of network autonomicity for DC energy management [4]

Category	Name	Definition	Man-Machine Interface	Decision Making Participation	Data Collection and Analysis	Degree of Intelligence	Environment Adaptability	Supported Scenarios
Category 0	Manual O&M	O&M personnel manually control the cooling	How (command)	All-manual	manual measurement of room temperature	Lack of AI based understanding (manual management and control)	Fixed	Single scenario
Category 1	Assisted O&M	Partially automated temperature tuning based on environmental changes	How (command)	Temperature sensors can be used to assist	Local awareness (room temperature and rack temperature)	Limited analysis capability	Limited adaptability to changes	Selected scenarios
Category 2	Partial automation	Automation of local temperature and partial adjustments of services according to predefined rules	HOW (declarative)	The control module provides suggestions, and makes limited decisions such as changing the temperature	Comprehensive analysis (historical temperature curves and IDC services data)	Deep analysis capability	Limited adaptability to changes	Selected scenarios
Category 3	Conditional automation	Automatic control and adaptation of temperature and IDC services in specific conditions	HOW (declarative)	Most of the machines make decisions	Comprehensive and adaptive sensing (such as data compression and optimization technologies)	Comprehensive analysis and knowledge; forecast capability	Adaptability to significant changes	Multiple scenarios
Category 4	Partial autonomicity	Deep awareness of temperature status and IDC service demands; autonomic decision-making and operation adjustment in most cases	WHAT (intent)	Optional decision-making	Adaptive posture awareness	Comprehensive analysis and knowledge Forward forecast capability	Adaptability to significant changes	Multiple scenarios
Category 5	Full autonomicity	The IDC services and cooling system can automatically adapt to all environmental and network conditions	WHAT (intent)	Machine autonomic decision	Adaptive optimization upon quality of service deterioration	Autonomic based on knowledge reasoning	Adaptability to any change	Any scenario

For #2 goal, to evaluate the performance of the proposed system, a few steps can be taken:

1. The speed of the throughput of the proposed energy mangagement policies by the PoC system against the original system without any AI algorithms applied.

2. The resouces required by the proposed PoC system compared to systems without applying AI algorithms.

3. DC PUE performance and power comsumption savings compared between systems equipped with ENI capabilities and the ones without it

2.4 Additional information

[1] RGS/ENI-008 (GS ENI 001), “Experiential Networked Intelligence (ENI); ENI use cases”, v2.1.1
[2] RGS/ENI-007 (GS ENI 002), “Experiential Networked Intelligence (ENI); ENI requirements”, v2.1.1
[3] DGR/ENI-004 (GR ENI 004) “Experiential Networked Intelligence (ENI); Terminology”, v1.1.1.
[4] DGR/ENI-0011 (GR ENI 007) “Experiential Networked Intelligence (ENI); Categorization”, v1.1.1 Sec 5.5.3
[5] DGR/ENI-0017 (GR ENI 009) “Experiential Networked Intelligence (ENI); Data mechanisms”, v0.0.3.