ENI ISG - PoC Proposal Template

A.1 PoC Project Details

A.1.1 PoC Project

PoC Number (assigned by ETSI): PoC#20

PoC Project Name: IP Network Congestion Prediction and Prevention

PoC Project Host: China Unicom

Short Description: this PoC is meant to demonstrate the proposed network congestion prediction and prevention mechanisms based on Artificial Intelligence/Machine Learning (AI/ML) algorithms. In particular, these proposed mechanisms are aimed to control the data traffic entering the network, ensure that the communication subnet is not overwhelmed by the data flow sent by users, and make reasonable use of bottleneck resources.

This PoC is purposed to demonstrate the use case [#4-4: IP Network Congestion Prediction and Prevention] discussed in GS ENI 001 [1], and report on suitability of ENI Reference Architecture described in GS ENI 005 [2] for this PoC. In order to demonstrate the rationality of the implementation of automatic closed-loop technology scheme in this PoC, more new functional requirements will be proposed to GS ENI 002.

A.1.2 PoC Team Members

Table A.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 Unicom	Yes	Bingming Huang, huangbm7@chinaunicom.cn; Jiaqi Chen, chenjq103@chinaunicom.cn;	X	Network Service Provider	- User Stories / Use Cases definition - PoC development - PoC documentation - PoC demos
2	Purple Mountain Laboratories	No	Zheng Zhi, zhengzhi@pmlabs.com.cn		Others	- Design and improve the congestion prediction and prevention algorithm - Help with software and hardware infrastructure setup
3	Beijing University of Posts and Telecommunications	Yes	Lingqi Guo, guolingqi@bupt.edu.cn;		University	- Help with the test of algorithm
4	China Telecom	Yes	Yu Zeng, zengyu@chinatelecom.cn		Network Service Provider	-Participation in project discussions
5	Intel Corporation (UK) Ltd	Yes	Haining Wang, haining.wang@intel.com		Manufacturer	-Participation in project discussions

NOTE 1: Identify the PoC Point of Contact with an X.
NOTE 2: The Role will be network operator/service provider, infrastructure provider, application provider or other as given in the Definitions of ETSI Classes of membership.

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.

A.1.3 PoC Project Scope

A.1.3.1 PoC Goals

The PoC will demonstrate the use case [#4-4: IP Network Congestion Prediction and Prevention]. In particular, the proposed mechanisms are compliant with its initial context configuration, triggering conditions, operational flow, and post-conditions, as defined in GS ENI 001.

This PoC will demonstrate various requirements that are identified in GS ENI 002, including General requirements, Service orchestration and management, Data collection and analysis, Data learning, model training and iterative optimization, etc.

This PoC intends to test and validate functional blocks of ENI Reference Architecture that are identified in GS ENI 005 and report on the suitability of ENI Reference Architecture.

The main goals of this PoC are to show the feasibility and the benefits of network congestion control, especially before congestion occurs, and demonstrate in a testbed environment that how ENI system can support full closed-loop management of network congestion prediction and prevention. The detailed goals include:

- **PoC Project Goal #1: Traffic prediction&Congestion Warning**. Demonstrate the use of ML algorithms to be able to predict network traffic for a period of time in the future, and anticipate the occurrence of network congestion. Determine whether to trigger congestion warning mechanism by combining traffic prediction and resource assessment results. If congestion warning is triggered, the automatic generation of congestion optimization strategy is completed.
- **PoC Project Goal #2: automatic closed-loop management**. Deploy the system in an experimental IP backbone network to achieve a full closed-loop process from user demand intention analysis, traffic prediction, congestion control to user feedback, hoping to significantly improve the digital capabilities and operational efficiency of operators.

A.1.3.2 PoC Topics

PoC Topics identified in this clause need to be taken for the PoC Topic List identified by ISG ENI and publicly available, i.e. the three topics identified in clause 4.5 of the ENI PoC Framework. PoC Teams addressing these topics commit to submit the expected contributions in a timely manner.

Table A.2

PoC Topic Description (see note)	Related WI	Expected Contribution	Target Date
Assurance -> IP Network Congestion Prediction and Prevention	ENI-005(GS ENI 005 system architecture) – Stable draft ENI-007(GS ENI 002 Requirements)- Stable draft ENI-008(GS ENI 001 Use Cases) –Stable draft	1. Framework for intelligent congestion prevention based on prediction of network traffic. 2. Functional blocks for this PoC. 3. The feasibility of network congestion control using AI/ML algorithms 4. Report on the suitability of ENI Reference Architecture for this PoC	01/03/2025
NOTE: This column should be filled according to the contents of table 1.			

A.1.3.3 Other topics in scope

List here any additional topic for which the PoC plans to provide input/feedback to the ISG ENI.

Table A.3

PoC Topic Description	Related WI	Expected Contribution	Target Date

A.1.4 PoC Project Stages/Milestones

Table A.4

PoC Milestone	Stages/Milestone description	Target Date	Additional Info
P.S	PoC project submission	04/2024	
P.TP.1	PoC user story finalization	06/2024	Finalization of the high-level description of the two scenarios described In Section 2.
P.TP.1	PoC Test Plan 1	09/2024	Initial algorithm testbed up and running
P.D1	PoC Demo 1	12/2024	Webinar demo at an ENI plenary meeting.
P.C1	PoC Expected Contribution 1	TBD	Contributions to ENI requirements.
P.C2	PoC Expected Contribution 2	TBD	Contributions to ENI reference architecture.
P.R	PoC Report	03/2025	PoC-Project-End Feedback
P.E	PoC Project End	04/2025	Presented to ISG ENI for information
NOTE: Milestones need to be entered in chronological order.			

A.1.5 Additional Details

For example, URL, planned publications, conferences, etc.

A.2 PoC Technical Details

A.2.1 PoC Overview

With the evolvement of Internet based on TCP/IP, the scale, users and traffics of it have experienced an explosive growth since 1990's. The network congestion has become more serious and complex due to the ever-increasing network application types and dynamic network parameters such as active sessions and round-trip time. Congestion often results in decline of quality of service (QoS) in terms of transmission delay and throughput, while the network resource utilization like bandwidth and buffers are also affected seriously. The congestion control is always a hot spot in the field of network research.

The basic mode of network congestion control nowadays is that the end system is responsible for responding to congestion, while the router is responsible for monitoring network congestion. Congestion signals are perceived by the source system, and then the load injected into the network is adjusted. However, this mode cannot meet the customer experience needs of agile business opening and ‘zero-fault’ perception, and achieve the vision of ENI's ‘Better customer experience & Improved QoE of service’.

In order to break through the existing network congestion operation and maintenance optimization mode and process, this PoC proposes a more intelligent predictive and proactive solution with ENI ,that is IP network congestion prediction and prevention(IPNCPP).

The PoC is tend to be proposed to demonstrate the procedure of network congestion prediction and prevention in IP backbone network scenes. As shown in Fig 1, this PoC consists of two scenarios:

- The first scenario demonstrates that the AI/ML-based technique enables network congestion prediction and prevention, in particular, shows the procedure of implementing analyze and predict the traffic of each link in the IP network, and formulates optimization strategies for early warning links based on intelligent congestion control algorithms and traffic prediction algorithms.

- The second scenario shows the functionality of this system in the IP backbone network, specifically to realize second level intelligent routing adjustment, significantly improved customer experience.

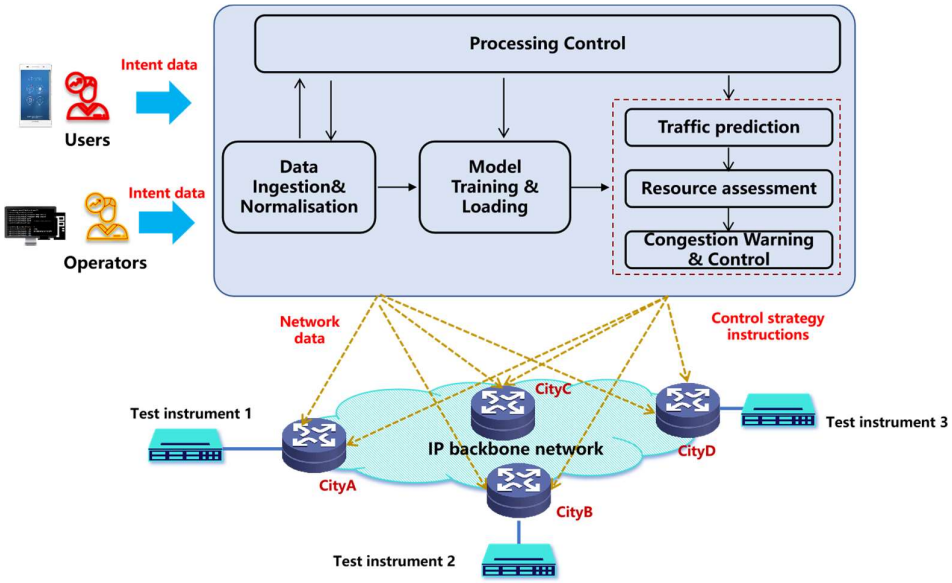

Figure 1 Scenario of this PoC

A.2.2 PoC Architecture

The diagram represented below shows the framework of the PoC mapping to the ENI reference architecture.

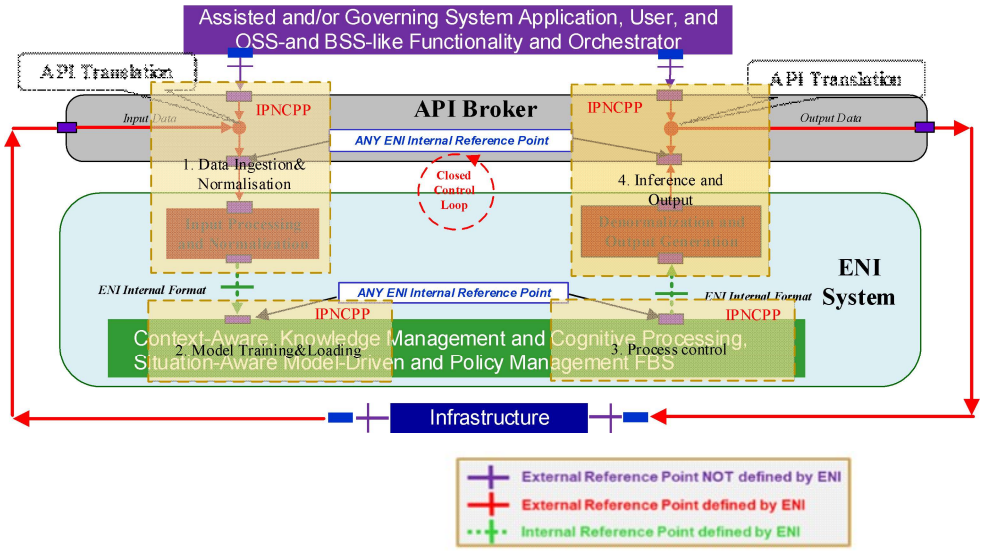

Figure 2: PoC architecture mapped to ENI reference

In order to achieve these two scenarios, the framework consists of the flowing stages:

1. The first stage is Date Ingestion and Procession, which maps to Data Ingestion and Data Normalization functional blocks (FBs) of ENI System. In this stage, the features, which includes network

performance data (e.g.: network traffic, alarms, etc.), network resource data (e.g.: network topology, link and service latency, jitters, packet loss rate, etc.), user business requirement/intention, are collected from IP backbone network nodes and users/operators by Operations support System (OSS) and Business Support Systems (BSS). Eventually, these data are transformed into a common format using statistic feature extraction algorithms and normalization algorithms so as to be further processed by other FBs.

2. The second stage is Model Training and Loading, which maps to Cognition Framework, Knowledge Management and Context-Aware Management FBs of the ENI System. In this stage, training datasets are fed into machine learning algorithms (e.g. Convolution Neural Network, and Recurrent Neural Network) to generate the models used to predict the traffic of each link in the IP network, and formulates optimization strategies for early warning links. Of course, the model's hyperparameters will be adjusted to get the optimal accuracy. When model training is finished, the model will be loaded into the functional entity to get ready to work. In this stage we will obtain two kinds of model called local prediction model and global prediction, which means there could have more than one local prediction model.

3. The third stage is the Process Control, which maps to Cognition Framework, Knowledge Management and Context-Aware Management FBs of the ENI System. In this stage, some policy adjustments might be presented. According to the collected data (network performance and operator intent info), the traffic prediction and congestion warning & control model may be retrained.

4. The fourth stage is Inference and Output, which maps to Knowledge Management, De-normalization and Output Generation FBs of the ENI system. In this stage, the pre-processed data and well-trained modules are implemented to complete uninterrupted traffic prediction and current network resource evaluation. Once abnormal trends or congestion faults are detected, optimization strategies are automatically generated through congestion warning and control algorithms, and optimization instructions are issued to the IP backbone network.

Based on the above stages, IP network congestion prediction and prevention system provides a solution which can be applied to dynamic network congestion control.

A.2.3 PoC Success Criteria

Explain how the proposal intends to verify that the goals are presented in clause A.1.2 have been met.

EXAMPLE: Functional (it worked, it did not work), Performance (transactions per second, throughput, processing per second, packet per second, etc.), Scalability, Availability, Service Quality.

A.2.4 Additional information

[1] RGS/ENI-008 (GS ENI 001), "Experiential Networked Intelligence (ENI); ENI use cases", v4.0.2 (stable draft), Sec 5.5.4.
[2] DGS/ENI-005 (GS ENI 005), "Experiential Networked Intelligence (ENI); System Architecture", v4.0.3 (stable draft).