ETSI GS ENI 005 V2.1.1 (2021-12)

Experiential Networked Intelligence (ENI); System Architecture

Disclaimer

The present document has been produced and approved by the Experiential Networked Intelligence (ENI) ETSI Industry Specification Group (ISG) and represents the views of those members who participated in this ISG.
It does not necessarily represent the views of the entire ETSI membership.

Reference
RGS/ENI-0016_Sys_Architecture

Keywords
architecture, API, artificial intelligence, closed control loop, cognition, functional architecture, functional block, intent management, management, model-driven engineering, network, policy management

ETSI

650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Contents

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™** and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM**® and the GSM logo are trademarks registered and owned by the GSM Association.

Foreword

This Group Specification (GS) has been produced by ETSI Industry Specification Group (ISG) Experiential Networked Intelligence (ENI).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

Executive summary

The present document specifies a high-level functional abstraction of the ENI System Architecture in terms of Functional Blocks and External Reference Points. This includes describing how different classes of systems interact with ENI. Processes, models, and detailed information are beyond the scope of the present document.

Introduction

The present document defines a high-level functional abstraction of the ENI System Architecture. The organization of the present document is as follows. Clause 1 defines the scope of the present document. Clauses 2 and 3 provide normative and informative references and definition of terms, respectively. Clause 4 provides an informative overview of the ENI System Architecture, including its motivation, benefits, important concepts, and an overview of its Functional Blocks. Clause 5 lists requirements of the ENI System Architecture. Clause 6 defines important design principles of the ENI System Architecture, and then specifies the different Functional Blocks that make up the ENI System Architecture. Clause 7 specifies the External Reference Points of the ENI System Architecture. Clause 8 describes how ENI interacts with other SDO Systems and clause 9 delineates a list of future study items.

1 Scope

The present document specifies the functional architecture of an ENI System, which is a high-level decomposition of an ENI System into its major components, along with a characterization of the externally visible behaviour (e.g. as defined by a set of reference points) of the components. This includes:

- defining the functionality and behaviour of a system that satisfy the ENI Requirements (ETSI GS ENI 002 [i.40]);
- defining a functional architecture, in terms of Functional Blocks, that addresses the goals specified by the ENI Use Cases (ETSI GS ENI 001 [3]);
- defining Reference Points used by the above Functional Blocks for all communication with systems and entities that are external to the ENI System;
- proposing a progression plan towards full support of the proposed ENI System and intermediary level of compliance (e.g. support of some architecture components or a subset of the Reference Points).

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are necessary for the application of the present document.

[1] ETSI GS NFV-MAN 001: "Network Functions Virtualisation (NFV); Management and Orchestration".

[2] IETF RFC 4949: "Internet Security Glossary, Version 2", Shirey, R., August 2007.

[3] ETSI GS ENI 001 (V3.1.1): "Experiential Networked Intelligence (ENI); ENI use cases".

[4] Strassner, J., Agoulmine N., Lehtihet, E.: "FOCALE - A Novel Autonomic Networking Architecture", ITSSA Journal 3(1), 64-79, 2007.

[5] Boyd, J. R.: "The Essence of Winning and Losing", June, 1995.

[6] Strassner. J.: "Knowledge Representation, Processing, and Governance in the FOCALE Autonomic Architecture", chapter 11 of Autonomic Network Management Principles, 2011, Elsevier.

[7] MEF 78.1: "MEF Technical Specification: MEF Core Model", Strassner, J., editor, July 2020.

NOTE: Available at: https://www.mef.net/resources/mef-78-1-mef-core-model-mcm/.

[8] MEF 95: "MEF Policy Driven Orchestration", Strassner, J, editor, July 2021.

NOTE: Available at: https://www.mef.net/resources/mef-95-mef-policy-driven-orchestration.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Strassner, J.: "Policy-Based Network Management", Morgan Kaufman, ISBN 978-1558608597, September 2003.

[i.2] Strassner, J., de Souza, J.N., Raymer, D., Samudrala, S., Davy, S., Barrett, K.: "The Design of a Novel Context-Aware Policy Model to Support Machine-Based Learning and Reasoning", Journal of Cluster Computing, Vol 12, Issue 1, pages 17-43, March, 2009.

[i.3] Strassner, J., van der Meer, S., O'Sullivan, D., and Dobson, S.: "The Use of Context-Aware Policies and Ontologies to Facilitate Business-Aware Network Management", Journal of Network and Systems Management 17(3), pages 255-284, 2009.

[i.4] Strassner, J., Betser, J., Ewart, R., Belz, F.: "A Semantic Architecture for Enhanced Cyber Situational Awareness", Secure and Resilient Cyber Architectures Conference, MITRE, 2010.

[i.5] Gamma, E., Helm, R. Johnson, R., Vlissides, J.: "Design Patterns: Elements of Reusable Object-Oriented Software", Addison-Wesley, Nov, 1994. ISBN 978-0201633610.

[i.6] Bäumer, D. Riehle, W. Siberski, M. Wulf: "The Role Object Pattern", Proceedings of the 1997 Conference on Object-Oriented Programming Systems, Languages and Applications (OOPSLA '97), ACM Press, 1997, Page 218-228.

[i.7] Chin, K.O., Ganb, K.S., Alfred, R., Anthony, P, and Lukose, D.: "Agent Architecture: An Overview", Transactions on Science and Technology, vol 1, No 1, pp 18-35, 2014.

[i.8] Shehory, O and Sturm, A., editors: "Agent-Oriented Software Engineering", Springer, 2014.

[i.9] Martin, R. C.: "Agile Software Development, Principles, Patterns, and Practices", Prentice Hall, 2003 ISBN 978-0135974445.

[i.10] Ritter, F.E., Tehranchi, F., Oury, J.D.: "ACT-R: A Cognitive Architecture for Modeling Cognition", Wiley Interdisciplinary Reviews, Cognitive Science 10(4): e1488.

[i.11] IETF RFC 8328: "Policy-Based Management Framework for the Simplified Use of Policy Abstractions (SUPA)", Liu, W., Xie, C., Strassner, J., Karagiannis, G., Klyus, M., Bi, J., Cheng, Y., and D. Zhang.

[i.12] Rothenberg, J.: "The Nature of Modelling", Artificial Intelligence, Simulation, and Modeling, John Wiley and Sons, Inc., 1989, pp. 75-92.

[i.13] Recommendation ITU-T 9594-1: "Information Technology - Open Systems Interconnection - The Directory: Overview of Concepts, Models, and Services".

[i.14] Recommendation ITU-T 9594-7: "Information Technology - Open Systems Interconnection - The Directory: Selected Object Classes".

[i.15] ETSI GR ENI 003 (V1.1.1): "Experiential Networked Intelligence (ENI); Context-Aware Policy Management Gap Analysis".

[i.16] REGULATION (EU) 2016/679, 'General Data Protection Regulation', 2016.

NOTE: Available at: https://gdpr.eu/tag/gdpr/

[i.17] Mitchell, Tom M.: "Machine Learning", McGraw-Hill, 978-0070428072.

[i.18] Gruber, Thomas R.: "Toward Principles for the Design of Ontologies Used for Knowledge Sharing", International Journal of Human Computer Studies, Vol 43, pp 907-928, 1993.

[i.19] Buschmann, F., Meunier, R., Rohnert, H., Sommerlad, P., and Stal, M.: "Pattern-Oriented Software Architecture - A System of Patterns", John Wiley and Sons, 1996.

[i.20] IEEE P7003: "Algorithmic Bias Considerations".

NOTE: Available at http://sites.ieee.org/sagroups-7003/.

[i.21] The Moral Machine.

NOTE: Available at https://www.media.mit.edu/projects/moral-machine/overview/.

[i.22] The Moral Machine project demonstration.

NOTE: Available at http://moralmachine.mit.edu/.

[i.23] Anderson, M. and Anderson, S.L.: "GenEth: A general ethical dilemma analyzer", AAAI, pgs 253-261, 2014.

[i.24] Cointe, N., Bonnel, G., and Boissier, O.: "Ethical judgment of agents' behaviors in multi-agent systems", AAMAS, pgs 1106-1114, 2016.

[i.25] The IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems.

NOTE: Available at https://standards.ieee.org/industry-connections/ec/autonomous-systems.html.

[i.26] Gartner: "Magic Quadrant for Full Life Cycle API Management", October, 2019.

[i.27] Koene, A., Smith, A.L., Egawa, T., Mandalh, S., and Hatada, Y.: "IEEE P70xx, Establishing Standards for Ethical Technology", KDD, 2018.

[i.28] Rao, A.S. and Georgeff, M.P.: "BDI Agents: From Theory to Practice", AAAI, 1995.

[i.29] IEEE: Ethically Aligned Design: "A Vision for Prioritizing Human Well-being with Autonomous and Intelligent Systems".

NOTE: Available at https://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/ead_v2.pdf.

[i.30] Famaey, J., Latré, S., Strassner, J., and De Turck, F.: "An Ontology-Driven Semantic Bus for Autonomic Communication Elements", IEEE International Workshop on Modeling Autonomic Communication Environments, pgs 37-50, 2010.

[i.31] OMG: "Semantics of Business Vocabulary and Rules", version 1.5, December, 2019.

[i.32] Attempto Controlled English.

NOTE: Available at http://attempto.ifi.uzh.ch/site/resources/.

[i.33] ETSI GR ENI-008 (V0.0.20): "Experiential Networked Intelligence (ENI); Intent Aware Network Autonomicity", September 2020.

[i.34] Hohpe, G. and Woolf, B.: "Enterprise Integration Patterns", Addison-Wesley, 2003, ISBN 9780321200686.

[i.35] ETSI GR ENI 016 (V1.1.1): "Experiential Networked Intelligence (ENI); Functional Concepts for Modular System Operation".

[i.36] ETSI GR ENI 017 (V1.1.1): "Experiential Networked Intelligence (ENI); Overview of Prominent Control Loop Architectures".

[i.37] ETSI GR ENI 018 (V1.1.1): "Experiential Networked Interlligence (ENI); Introduction to Artificial Intelligence Mechanisms for Modular Systems".