Draft new Supplement ITU-T Y.3184 series (Y.Sup-Mec-CONA)

Mechanism for customer-oriented intelligent awareness of network status

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Mechanism for customer-oriented intelligent awareness of network status

1 Scope

This Supplement to ITU-T Y.3184 Recommendations specifies the mechanism for customer-oriented intelligent awareness of network status. It aims to bridge the gap between network technical performance and customer-oriented service quality perception. By ensuring a holistic view of both technical performance and user experience, it will enhance overall customer satisfaction and operational efficiency in the context of evolving network architectures and diverse service requirements.

The scope includes four aspects:

1) Overview of customer-oriented intelligent awareness of network status.
2) Capabilities for customer-oriented intelligent awareness of network status.
3) Mechanism for customer-oriented intelligent awareness of network status.
4) Security considerations.

2 References

The following ITU-T Recommendations and other references contain provisions, which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T Y.3184] ITU-T Recommendation ITU-T Y.3184 (2023), Mechanism for intelligent awareness of network status.

[ITU-T Y.3185] ITU-T Recommendation ITU-T Y.3185 (2023), *Functional architecture for intelligent awareness of network requirements*

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3 Definitions

3.1 Terms defined elsewhere

3.1.1 big data [b-ITU-T Y.3600]: A paradigm for enabling the collection, storage, management, analysis and visualization, potentially under real-time constraints, of extensive datasets with heterogeneous characteristics.

3.1.2 machine learning (ML) [ITU-T Y.3172]: Processes that enable computational systems to understand data and gain knowledge from it without necessarily being explicitly programmed.

3.1.3 machine learning model [ITU-T Y.3172]: Model created by applying machine learning techniques to data to learn from.

NOTE 1 – A machine learning model is used to generate predictions (e.g., regression, classification, clustering) on new (untrained) data.

NOTE 2 – A machine learning model may be encapsulated in a deployable fashion in the form of a software (e.g., virtual machine, container) or hardware component (e.g., Internet of Things(IoT) device).

NOTE 3 – Machine learning techniques include learning algorithms (e.g., learning the function that maps input data attributes to output data).

3.1.4 Closed loop [ITU-T Y.3115]: A type of control mechanism in which the outputs and behaviour of a system are monitored and analysed, and the behaviour of the system is adjusted so that improvements may be achieved towards definable goals.

NOTE 1 – Observe, Orient, Decide and Act (OODA) [b-OODA], MAPE-K [b-MAPE-K] are examples of closed loop mechanism.

NOTE 2 – Examples of definable goal types are optimization of network resources' utilization and automated service fulfilment and assurance. Goals may be defined using declarative mechanisms.

NOTE 3 – The system may consist of a set of managed entities, workflows and/or processes in a network.

3.1.5 machine learning overlay [ITU-T Y.3172]: A loosely coupled deployment model of machine learning functionalities whose integration and management with network functions are standardized.

NOTE – A machine learning overlay aims to minimise interdependencies between machine learning functionalities and network functions using standard interfaces, allowing for parallel evolution of functionalities of the two.

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3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

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4 Abbreviations

This Recommendation uses the following abbreviations and acronyms:

AI	Artificial Intelligence
DL	Deep Learning
INSA	Intelligent Awareness of Network status
INSA-CO	Customer-oriented intelligent awareness of network status
IoT	Internet of Things
ML	Machine Learning
NA	Network Awareness
NSA	Network Status Awareness

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5 Conventions

In this Recommendation:

The keywords "is required to" indicate a requirement which must be strictly followed and from which no deviation is permitted, if conformance to this Recommendation is to be claimed.

The keywords "is recommended" indicate a requirement which is recommended but which is not absolutely required. Thus, this requirement need not be present to claim conformance.

The keywords "can optionally" and "may" indicate an optional requirement which is permissible, without implying any sense of being recommended. This term is not intended to imply that the vendor's implementation must provide the option, and the feature can be optionally enabled by the network operator/service provider. Rather, it means the vendor may optionally provide the feature and still claim conformance with this Recommendation.

6 Overview of customer-oriented intelligent awareness of network status

The ITU-T Recommendations Y.3184 and Y.3185 have introduced methodologies to achieve Intelligent Network Status Awareness (INSA) through the establishment of standardized mechanisms for AI/ML-driven analysis of network faults, performance, resource utilization, and load dynamics. These Recommendations facilitate the transformation of raw infrastructure telemetry into actionable insights, thereby improving proactive network management and optimization. Nevertheless, as networks continue to evolve to support an increasingly diverse range of high-quality services, persistent limitations remain in aligning technical performance with customer-oriented service quality perception.

This draft Supplement primarily builds upon ITU-T Y.3184 by introducing a customer-oriented intelligent awareness of network status (INSA-CO) mechanism and related functional components, aiming to support the achievement of the following key objectives:

Customer-oriented Experience Evaluation Mechanism:

Establish a unified framework to correlate network status indicators with real-time customer experience metrics. This mechanism identifies critical network factors and events impacting customer experience through multidimensional data fusion and AI-driven pattern recognition, ultimately enabling granular visibility into service quality gaps.

Customer-oriented Proactive Experience Assurance

Deliver intelligent, preemptive assurance by detecting early signs of service degradation (e.g., micro-congestion in edge nodes) through continuous analysis of traffic patterns and infrastructure telemetry. Adaptive policies (e.g., traffic rerouting, resource pre-allocation) are autonomously deployed to mitigate risks before customers perceive disruptions, ensuring seamless service continuity.

Customer-oriented Network Orchestration and Operations

Optimize network configurations by aligning resource allocation and traffic engineering with static customer attributes (e.g., ToB users: industry-specific latency thresholds for smart factories; ToC users: VIP subscriber tiers) and dynamic behavioral contexts (e.g., real-time bandwidth adjustments for streaming-heavy users). By utilizing predictive models to anticipate service demands (e.g., AR/VR traffic surges during live events), network operators achieve agile and customer experience-centric network operations.

NOTE 1: In this context, "customer-oriented" refers to an approach that prioritizes the needs, expectations, and experiences of customers, distinguishing it from traditional methods that focus solely on device and network metrics. It emphasizes the integration of customer experience-centric insights into network management and optimization processes, ensuring that service quality aligns with customer requirements and perceptions.

Figure 6-1 shows a conceptual model for INSA-CO. The left part of Figure 1 is the typical model for intelligent awareness of network status [ITU-T Y.3184], which contains three main parts related to network status awareness: network status sensing, network status analyzing, and network status reporting and displaying; the right part is the deployed functional entities of customer-oriented intelligent insights enhancement, which contains three parts corresponding to the three parts in typical model for intelligent awareness of network status respectively:

1) Customer Experience-Centric Perception Layer

- Subjective Perception: Real-time user feedback (e.g., customer complaints & demand, QoE surveys) and behavioral insights (e.g., session abandonment rates, application usage patterns).
- Objective Perception: Augments network data with application-layer KPIs (e.g., video stutter ratio, AR/VR motion-to-photon latency) and indicators from user perception evaluation system based on XDR, DPI.

NOTE 2: Traditional network status sensing focuses on raw measurement data (e.g., packet loss, bandwidth utilization), while this layer incorporates subjective and objective perception fusion mechanisms. This dual-path perception enables granular visibility into user-experience degradation even when infrastructure metrics remain nominal.

2) Customer Experience-Centric Analysis Layer

- Customer Experience Pattern Clustering and Classification: Groups customer feedback into distinct experience profiles; categorizes service anomalies into customer-impacting classes based on severity and service type.
- Predictive Modeling for Customer Experience Risk: Forecasts potential service degradation using time-series analysis of historical customer behavior and network telemetry.
- Root Cause Inference for Customer Experience Impact: Traces service failures to network root causes via causal reasoning engines prioritizing customer-reported issues.
- Dynamic Policy Generation for Customer Experience Optimization: Creates adaptive network configurations based on real-time customer behavior and vertical-specific requirements.

3) Customer Experience-Centric Application Layer

- Service Assurance Reports: Generates actionable dashboards highlighting dynamic customer experience and trends, and corresponding customer-specific optional network policies.
- Network strategy recommendations: Provides optional network policy to support personalised customer demands and enhance the customer experience.
- Customer Feedback-Driven Adaptation: Iteratively refines network policies based on post-resolution surveys and real-time satisfaction metrics.

By embedding these enhancements, the model shifts network management objectives from optimizing infrastructure metrics to maximizing customer satisfaction, particularly in scenarios with heterogeneous service demands.

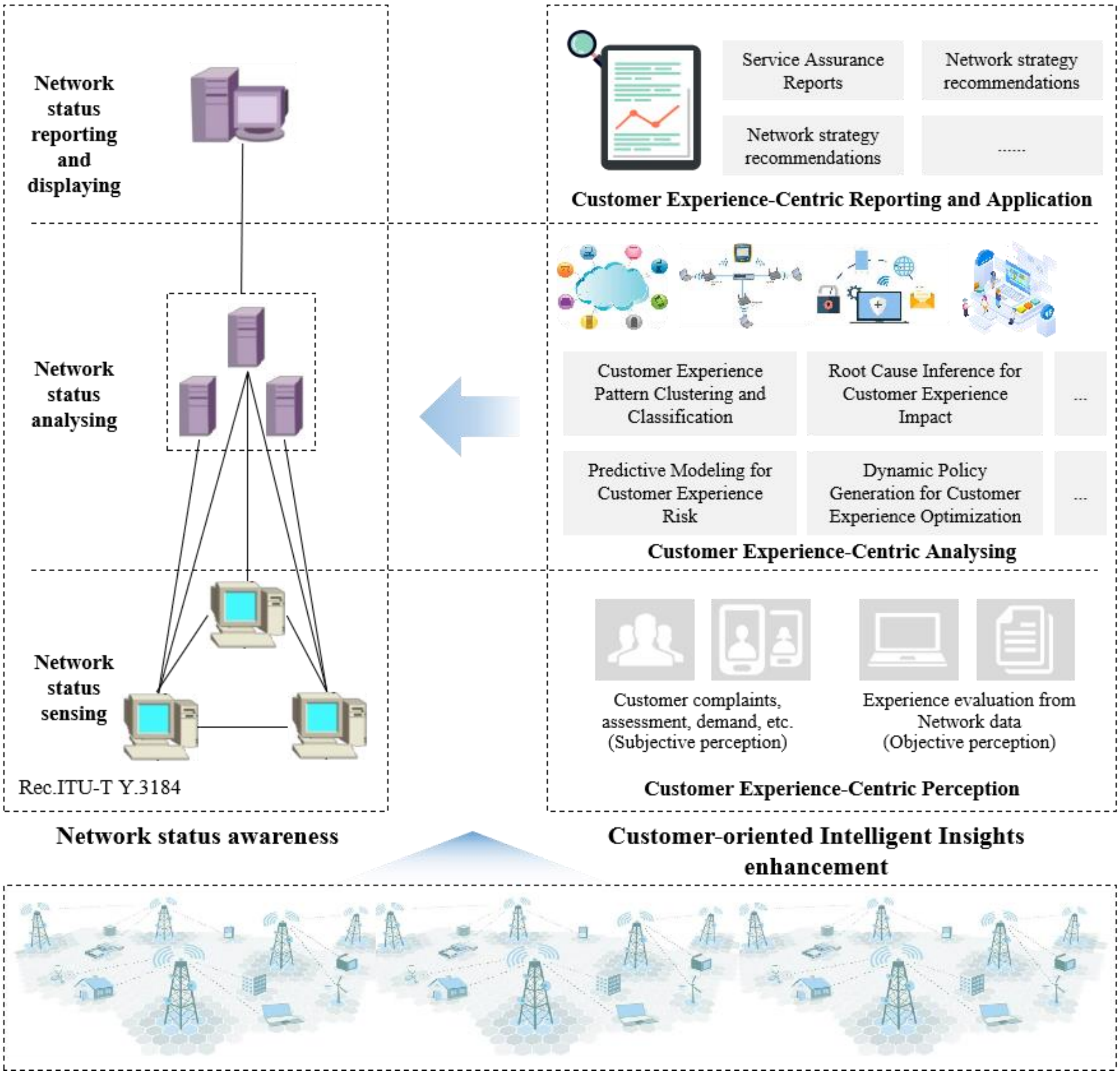

Figure 6-1 Conceptual model for INSA-CO

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7 Capabilities for customer-oriented intelligent awareness of network status

7.1 General capabilities

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7.2 Customer experience-centric application layer

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7.3 Customer experience-centric analysis layer

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7.4 Customer experience-centric perception layer

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8 Mechanism for customer-oriented intelligent awareness of network status

8.1 General mechanism

Figure 8-1 describes the general mechanism for INSA-CO, comprising 4 planes: data plane, awareness plane, control plane, and management plane. The awareness plane acts as the cognitive core, integrating an customer-oriented service orchestration engine to unify network-centric metrics with customer experience-centric perception data. This mechanism bridges the gap between network status awareness and user experience perception by embedding user experience-centric intelligence, transforming network operations from reactive infrastructure management to proactive experience assurance.

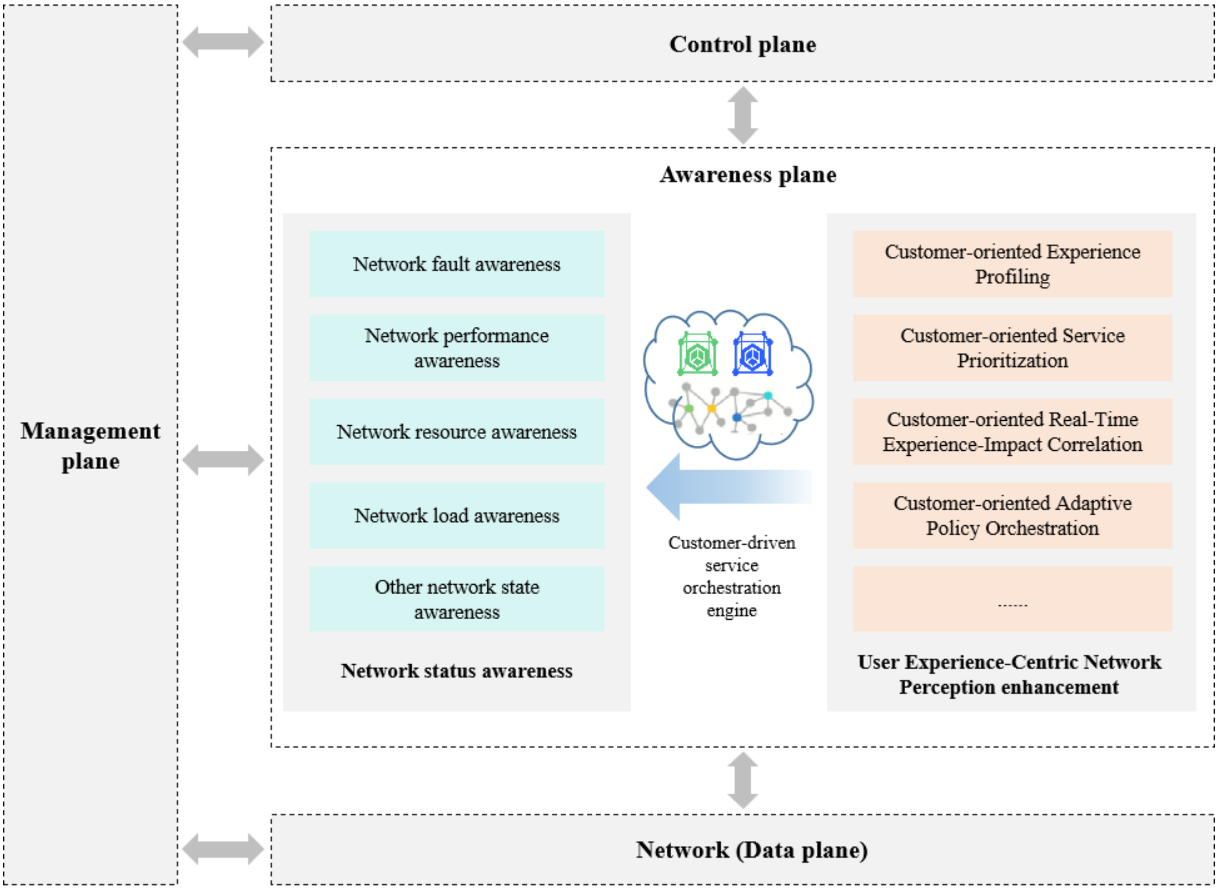

Figure 8-1 General mechanism for INSA-CO

1) Awareness Plane: synthesizes customer experience-centric capabilities through AI-driven analytics, enabling proactive alignment of network operations with customer expectations, serving as the cognitive core of INSA-CO.

- **Customer-oriented Experience Profiling:** Integrates multi-source data (e.g., customer complaints, QoE, application KPIs) to construct dynamic customer experience portrait, highlighting pain points of different kinds of customers (e.g., frequent buffering during live events).
- **Customer-oriented Service Prioritization:** Identifies mission-critical service requirements (e.g., To B: ultra-low latency for industrial robots; To C: 4K streaming, AR/VR, gaming) through contextual analysis of customer usage patterns and SLA commitments.
- **Customer-oriented Real-Time Experience-Impact Correlation:** Maps network anomalies (e.g., micro-bursts in core links) to customer-facing service degradation (e.g., video conferencing freezes) using AI learning models trained on cross-domain customer data.
- **Customer-oriented Adaptive Policy Orchestration:** Generates context-aware optimization strategies by balancing infrastructure efficiency with real-time customer satisfaction metrics.

NOTE: Ensure customer privacy through technologies such as federated learning and data desensitisation, and no individual customer data will be used in the whole process of INSA-CO.

2) Data Plane: Aggregates and preproccess customer experience-centric data for analysis by the awareness plane.

- **Data Aggregation:** Collects raw infrastructure metrics (e.g., latency, packet loss) and customer experience signals (e.g., QoE scores, session drop rates) from edge devices, IoT sensors, and cloud platforms.
- **Customer Context Tagging:** Embeds customer attributes (e.g., enterprise IoT device, VIP subscriber) into data streams to enable differentiated routing and QoS prioritization.

3) Control Plane: Validates and deploys customer experience-centric policies generated by the awareness plane to ensure alignment with real-time service quality objectives.

- **Customer-oriented Policy Validation:** Verifies feasibility of awareness plane strategies (e.g., traffic prioritization) against real-time network states and customer SLA constraints.
- **Customer-oriented Adaptive Configuration Dispatch and Feedback:** Executes context-aware network adjustments (e.g., edge compute provisioning, QoS tuning) to address service degradation risks; monitors post-implementation outcomes and feeds results back to iteratively refine awareness plane models.

4) Management Plane: implement customer experience-centric strategies through proactive maintenance and resource orchestration guided by awareness plane intelligence.

- **Customer-oriented Network Maintenance:** Implements self-healing workflows triggered by predictive models trained on customer experience.
- **Customer-oriented Resource Orchestration:** Dynamically allocates resources based on real-time customer demand heatmaps (e.g., gaming traffic surges during peak hours).
- **Customer-oriented Experience Management:** Ensures end-to-end alignment between network performance and business KPIs through continuous policy recalibration.

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8.2 Mechanism for customer-oriented network fault awareness

According to ITU-T Y.3184, Intelligent awareness of network faults is responsible for sensing the network faults that have occurred as well as the network faults that will possibly occur. In addition, intelligent awareness of network faults should attempt to trace the root errors of the network fault, predict the future network faults and give some suggestions to handle those network faults. A complete process of intelligent awareness for network fault includes five main procedures: multiple-dimensional network status data collecting, network fault correlation analysis, root errors of the network fault tracing, future fault prediction, and network fault related proposal generating based on machine learning. Based on Y.3184, Figure 8-2 describes the process for customer-oriented intelligent awareness for network fault.

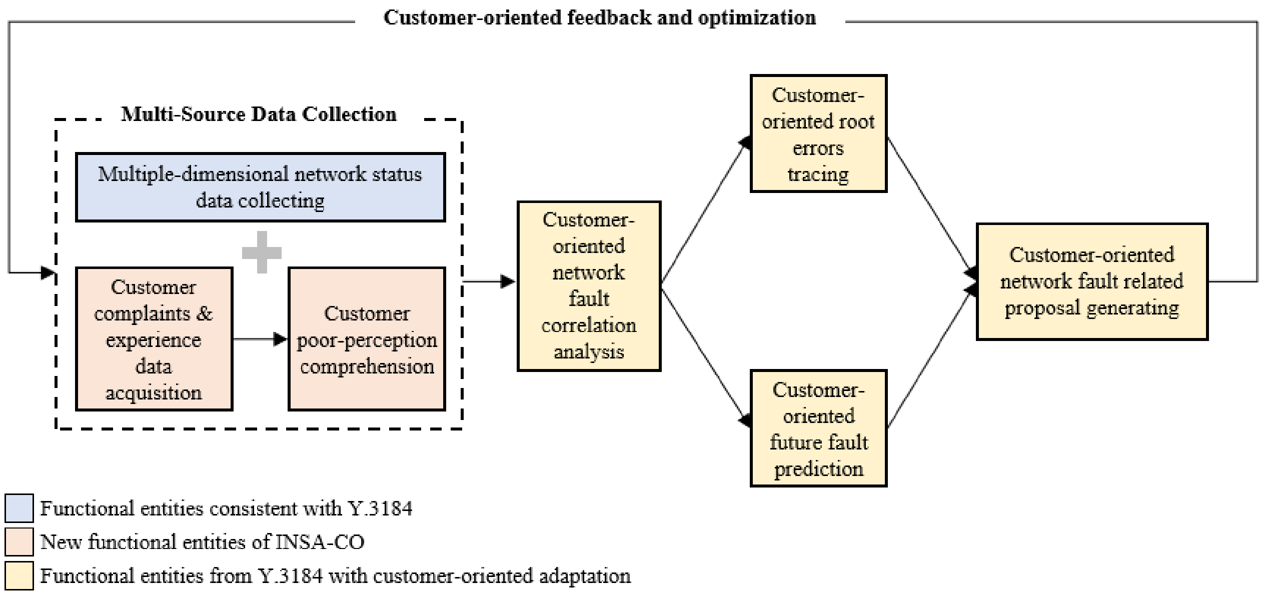

Figure 8-2 Process for customer-oriented intelligent awareness for network fault

1) Multi-source data collection

The first procedure is aggregating customer experience-centric data and network metrics to establish a holistic view of service disruptions and fault. Natural Language Processing categorizes unstructured feedback, while real-time KPIs capture infrastructure health, ensuring alignment between technical metrics and customer-reported issues.

2) Customer-oriented network fault correlation analysis

AI models correlate customer-reported symptoms with network anomalies. Spatial-temporal analysis identifies complaint clusters, enabling operators to prioritize regions or services where customer experience degradation is concentrated.

3) Customer-oriented root errors tracing

Causal inference models trace faults to infrastructure root causes or external factors. Prioritization is based on customer impact severity, ensuring resources address widespread service degradation before localized issues, thereby minimizing user dissatisfaction.

4) Customer-oriented future fault prediction

Historical fault and feedback data predict high-risk scenarios. Actions mitigate outages before customers perceive disruptions, transforming reactive operations into proactive experience assurance.

5) Customer-oriented network fault related proposal generating

Dynamic repair strategies are generated using AI-driven knowledge bases, balancing technical feasibility with customer experience-centric SLA requirements. This ensures resolutions directly improve perceived service quality.

6) Customer-oriented feedback and optimization

Post-resolution, customer satisfaction surveys and updated network metrics refine AI models. Iterative learning adapts to emerging complaint patterns, closing the loop between technical fixes and customer expectations.

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8.3 Mechanism for customer-oriented network performance awareness

According to ITU-T Y.3184, Intelligent awareness of network performance is sensing the current performance situation, predicting future performance situation and bringing forward a proposal to improve the performance of the network. A complete process of intelligent awareness for network performance includes four main procedures: network performance data collecting, network performance data analysis, future network performance predicting, and network performance proposal generating. Based on Y.3184, Figure 8-3 describes the process for customer-oriented intelligent awareness for network fault.

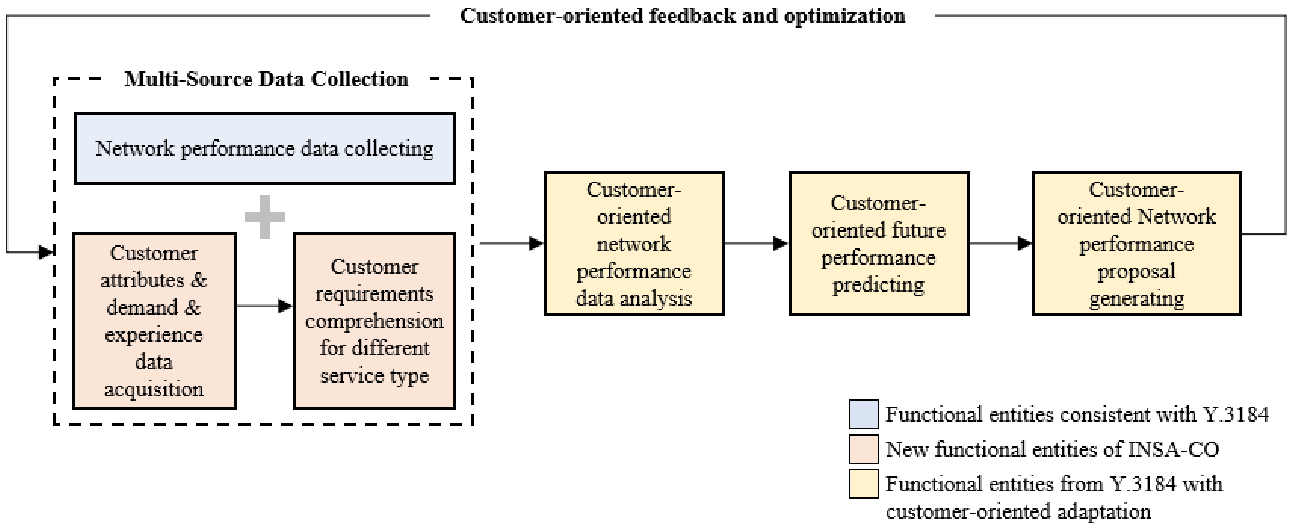

Figure 8-3 Process for customer-oriented intelligent awareness for network performance

1) Multi-source data collection

The process begins with the acquisition of customer attributes, demand patterns, and experiential data across service types, including explicit feedback and implicit behavioral indicators. Advanced analytics integrate these inputs with network telemetry to comprehensively map service-specific pain points, ensuring technical performance metrics are directly tied to subjective customer perceptions.

2) Customer-oriented network performance analysis

AI-driven clustering dynamically categorizes services into demand-aligned classes by correlating technical thresholds with customer expectations. Anomaly detection identifies deviations from service-specific benchmarks, prioritizing optimization targets based on severity of customer impact to focus resources on high-value experience gaps.

3) Customer-oriented future performance prediction

Predictive models analyze historical customer behavior trends and network utilization patterns to forecast service demand fluctuations. These insights enable preemptive resource scaling strategies aligned with anticipated customer needs, ensuring capacity readiness for critical usage scenarios.

4) Customer-oriented network performance proposal generation

Adaptive optimization policies are generated by balancing infrastructure efficiency with real-time customer satisfaction metrics. For example, latency-sensitive services receive edge prioritization, while bandwidth-intensive applications trigger dynamic caching, ensuring SLA compliance tailored to vertical-specific requirements.

5) Customer-oriented feedback and optimization

Post-implementation evaluations measure improvements in customer experience-centric data and network metrics. Continuous model retraining with updated behavioral data ensures sustained alignment with evolving customer expectations, closing the loop for experience-driven operations.

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8.4 Mechanism for customer-oriented network resource awareness

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8.5 Mechanism for customer-oriented network load awareness

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8.6 Mechanism for other aspects of network status awareness

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9 Security considerations

Editor's note on March 2025.: Security considerations will include controls on customer-specific data access, data abstraction methodologies, and data deletion requirements.

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Appendix I - Use cases for customer-oriented intelligent awareness of network status

I.1 Network Fault Detection by INSA-CO

In Region A, customers reported live stream freezing during peak hours (20:00–22:00), with increasing complaint density, despite no errors being detected in network or equipment metrics. To address this, a INSA-CO approach was implemented. Multi-source data fusion combined structured customer complaints, such as "Live stream lag during prime time," with unstructured social media sentiment, including trending hashtags like "#RegionAStreamingFail." Real-time network telemetry captured CDN node loads, peering link congestion rates, and HTTP error codes, while application-layer KPIs, such as buffering ratios exceeding 15%, identified service degradation points.

Spatiotemporal clustering revealed that the majority of complaints originated from areas served by a specific CDN node, which exhibited high CPU utilization during peak hours. Causal inference traced the issue to undersized peering links between the CDN node and a partnering ISP, confirmed through controlled traffic redirection tests that demonstrated significant latency reduction. Short-term mitigation strategies included prioritizing livestream traffic via QoS tagging and deploying edge cache bursting during peak windows. Long-term solutions involved upgrading peering links and deploying additional edge CDN nodes in underserved areas. Automated notifications kept customers informed of restoration progress, including estimated resolution timelines.

Post-implementation monitoring showed a significant reduction in buffering ratios and customer complaints, while sentiment analysis reflected positive trends on social media. Machine learning models were retrained using updated traffic patterns to preempt similar issues during future high-demand events. By integrating customer feedback into fault detection and resolution, technical optimizations directly improved user experience. This approach not only provided operators with actionable insights to preempt service degradation but also enhanced customer perception of reliability and transparency, fostering a cycle of continuous service improvement and customer loyalty.

I.2 Network Performance Enhancement for Diverse Service Demands by INSA-CO

In a scenario where VIP subscribers encounter issues like gaming lag with a latency of 30ms or more, as well as 4K streaming buffering during concurrent usage, which violates Service-Level Agreements (SLAs), INSA-CO takes a series of effective measures. Firstly, it conducts VIP customer contextual profiling. Through hierarchical data tagging, VIP devices and service types can be identified. Behavioral analysis shows that a significant proportion of latency-sensitive gaming sessions overlap with bandwidth-heavy streaming.

Then, based on customer demands, resource orchestration is carried out. For gaming services, edge computing resources with a latency guarantee of less than 10ms are dedicated by using SRv6 steering. As for streaming services, 4K content is pre-cached at edge nodes according to viewing history predictions. And for chat and browsing services, "always-on" low-priority bandwidth with adaptive compression is allocated.

Moreover, dynamic experience balancing is achieved by an AI-driven policy engine. When gaming and streaming services coexist, it can dynamically throttle background app updates, thus reducing contention. Real-time Quality of Experience (QoE) dashboards are in place to trigger VIP-tier compensation, such as free data boosts, if thresholds are breached. This helps to achieve a high level of SLA compliance, stabilize gaming latency at a low level, and significantly reduce streaming buffering, thereby enhancing the perception of premium services.

Bibliography

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Annex A
A.13 justification for proposed draft new Supplement ITU-T Y.Sup-Mec-CONA to Y.3184 “Mechanism for customer-oriented intelligent awareness of network status”

<table>
<tr><td>Question:</td><td>Q7/13</td><td colspan="2">Proposed new ITU-T:
☑ Supplement
☐ Implementer's guide
☐ Technical paper
☐ Technical report
☐ Handbook
☐ Other: ___________________________</td><td colspan="2">Geneva, 3-14 March 2025</td></tr>
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<tr><td colspan="6">Purpose and scope (defines what issue this non-normative document will address, thus permitting readers to judge its usefulness for their work; also defines the intent or objective of the non-normative document and the aspects covered, thereby indicating the limits of its applicability):
This draft Supplement to Y.3184 Recommendations specifies mechanism for customer-oriented intelligent awareness of network status. The scope of this supplement includes four aspects:
1) Overview for customer-oriented intelligent awareness of network status.
2) Capabilities for customer-oriented intelligent awareness of network status.
3) Mechanism for customer-oriented intelligent awareness of network status.
4) Security considerations.</td></tr>
<tr><td colspan="6">Summary (provides a brief overview of the proposal):
This draft Supplement to Y.3184 Recommendations specifies the mechanism for customer-oriented intelligent awareness of network status. The proposed enhancements incorporate a customer-oriented intelligent insights framework, which integrates a customer experience-centric perception layer, analysis layer, and application layer. The enhancements aim to augment the existing architecture with customer experience-centric capabilities, enabling the realization of customer-oriented intelligent awareness mechanisms for network fault detection, network performance monitoring, network resource allocation, network load management, etc.
This draft Supplement aims to provide a more holistic view of network status, ensuring that the perception of service quality from the customer perspective carries equal weight in network management and optimization efforts, thereby enhancing the overall quality and reliability of Intelligent Awareness of Network Status.</td></tr>
<tr><td colspan="6">Relations to ITU-T Recommendations or other documents (approved or under development):
ITU-T Y.3184, ITU-T Y3185, ITU-T Y.3047, ITU-T Y.ReqCapMec-SDNA, ITU-T Y.CNAO, ITU-T Y.bDDN-AM-COINO</td></tr>
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