broadband forum

TR-311
Fiber Infrastructure Management System: Architecture and Requirements

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Issue History

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Executive Summary

TR-311 addresses the architecture and functional requirements of emerging Fiber Infrastructure Management (FIM) systems that facilitate operations involving the physical plant layer of Passive Optical Networks. These requirements cover system architecture, layer functional requirements, and interfaces for interoperability with service provider Operations Support Systems (OSS).

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1. Purpose and Scope

1.1 Purpose

With the fast growth of FTTx, rapid deployment and effective maintenance of a new passive fiber network (i.e. an Optical Distribution Network, ODN) have become major challenges for operators. Service provisioning and maintenance of ODN have been inefficient and inaccurate with the following major flaws:

a) Massive number of fibers identified manually with paper labels
b) Work orders delivered in hard copy
c) Manual fiber connections not verified accurately with a manual check.
d) Port resources are updated by manual input with low efficiency and inaccuracy.

This reliance on paper records and manual actions leads to inefficiency and errors. The purpose of the Fiber infrastructure management systems (FIMS) is to remove the tendency for errors and increase efficiency by providing the means to reduce the manual actions involved in service provisioning and maintenance, and automate the recording of data and verification of correct manual actions.

1.2 Scope

TR-311 focuses on the definition of general requirements for FIMS, including the architecture, components requirements and interface requirements for interoperability for service provider OSS and, possibly, other operations systems such as NMS, AIM, and DCIM.

TR-311 covers the following topics:

a) Definition of the requirements
b) Definition of the reference architecture model
c) Detailed specification of functional and performance requirements for components
d) High level description of the interfaces
e) Use cases

TR-311 is based on electronic identification data (ID) tagging technologies. A future revision of this document may support remote optical measurement & control functions and a broader set of ID tag technologies.

2   References and Terminology

2.1 Conventions

In this Technical Report, several words are used to signify the requirements of the specification. These words are always capitalized. More information can be found be in RFC 2119 [2].

MUST	This word, or the term "REQUIRED", means that the definition is an absolute requirement of the specification.
MUST NOT	This phrase means that the definition is an absolute prohibition of the specification.
SHOULD	This word, or the term "RECOMMENDED", means that there could exist valid reasons in particular circumstances to ignore this item, but the full implications need to be understood and carefully weighed before choosing a different course.
SHOULD NOT	This phrase, or the phrase "NOT RECOMMENDED" means that there could exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications need to be understood and the case carefully weighed before implementing any behavior described with this label.
MAY	This word, or the term "OPTIONAL", means that this item is one of an allowed set of alternatives. An implementation that does not include this option MUST be prepared to inter-operate with another implementation that does include the option.

2.2 References

The following references are of relevance to this Technical Report. At the time of publication, the editions indicated were valid. All references are subject to revision; users of this Technical Report are therefore encouraged to investigate the possibility of applying the most recent edition of the references listed below.
A list of currently valid Broadband Forum Technical Reports is published at www.broadband-forum.org.

Document		Title	Source	Year
[1]	Rec. L.64	*ID Tag Requirements for Infrastructure and Network Elements Management*	ITU-T	2012
[2]	RFC 2119	*Key words for use in RFCs to Indicate Requirement Levels*	IETF	1997

2.3 Definitions

The following terminology is used throughout this Technical Report.

Optical Distribution Network (ODN)	The physical medium that connects an OLT to its subtended ONUs. The ODN is comprised of various passive components, including the optical fiber, splitter or splitters, and optical connectors.
Optical Line Terminal (OLT)	A device that terminates the common (root) endpoint of an ODN, implements a PON protocol, and adapts PON PDUs for uplink communications over the provider service interface. The OLT provides management and maintenance functions for the subtended ONUs.
Optical Network Unit (ONU)	A generic term denoting a functional element that terminates any one of the distributed (leaf) endpoints of an ODN, implements a PON protocol, and adapts PON PDUs to subscriber service interfaces. In some contexts an ONU supports interfaces for multiple subscribers.

2.4 Abbreviations

This Technical Report uses the following abbreviations:

AI	Application Interface
AIM	Automated Infrastructure Management
AN	Access Node
BSS	Business Support System
CO	Central Office
DCIM	Data Center Infrastructure Management
EMS	Element Management System
EPON	Ethernet Passive Optical Network
FIMT	Fiber Infrastructure Management Tool
FMP	Fiber Management Platform
FTTH	Fiber To The Home
GIS	Geographic Information System
GPON	Gigabit-capable Passive Optical Network
ID	Identification Data
NMI	Network Management Interface
NMS	Network Management System
ODF	Optical Distribution Frame
ODN	Optical Distribution Network
ONU	Optical Network Unit
OSS	Operations Support Systems

PDA	Personal Digital Assistant
PDU	Protocol Data Unit
PON	Passive Optical Network
RFID	Radio Frequency Identification
RMI	Resource Management Interface
SAI	Service Access Interface
TR	Technical Report
WDM	Wavelength Division Multiplexing

3   Technical Report Impact

3.1 Energy Efficiency

TR-311 has no impact on energy efficiency.

3.2 IPv6

TR-311 has no impact on IPv6.

3.3 Security

TR-311 has no impact on security.

3.4 Privacy

Any issues regarding privacy are not affected by TR-311.

4 Fiber Infrastructure Management Systems Overview

As the worldwide deployments of fiber access networks expand, network operators face increasingly challenging deployment, service provisioning, network operations and management, and maintenance issues associated with rapidly growing number of optical fibers and fiber connections/joints in their networks. These challenges originate from the passive nature of ODN components and management processes that are largely manual. With the development of electronic identification data (ID) tagging technologies, it has become possible to enable FIMS.

Essentially, a FIMS uses electronic ID tag technologies that include contact-type ID tag and non-contact-type ID (such as RFID) tag as defined by ITU-T Recommendation L.64 [2] to implement automated collection and synchronization of fiber connection resource data. As a result, accurate management and control of fiber connection scheduling is achieved. Moreover, integrated with other applications, FIMS provides an accurate and efficient management of the available fiber infrastructure network.

Fiber infrastructure management systems are expected to meet the following objectives:
- Using electronic ID tags to identify fibers without any deterioration in optical communication signals.
- Supporting automated fiber connection management based on the electronic work orders.
- Supporting automated port identification to achieve field operation guidance.
- Supporting automated fiber connection verification when field operations are conducted.
- Supporting automated collection of resource data related to fiber connections.
- Supporting automated resource data synchronization with OSS/BSS to ensure the accuracy of resource data.
- Supporting visualization of end-to-end fiber connection topology.
- Supporting visual fiber network infrastructure topology associated with GIS (Geographic Information Systems)-based data.

5 Functional Architecture of Fiber Infrastructure Management Systems

This section describes the high-level architecture of the fiber infrastructure management system. Figure 1 shows the functional block representation of a FIMS architecture which consists of a Work Order Management function, a Fiber Network Management function, and, a Node Management function in the Management Layer, and Data Collection function in the Data Collection and Control Layer. The ID block holds the resource data that is stored in the ODN equipment. The interfaces can be internal or external to a FIMS based on the implementation.
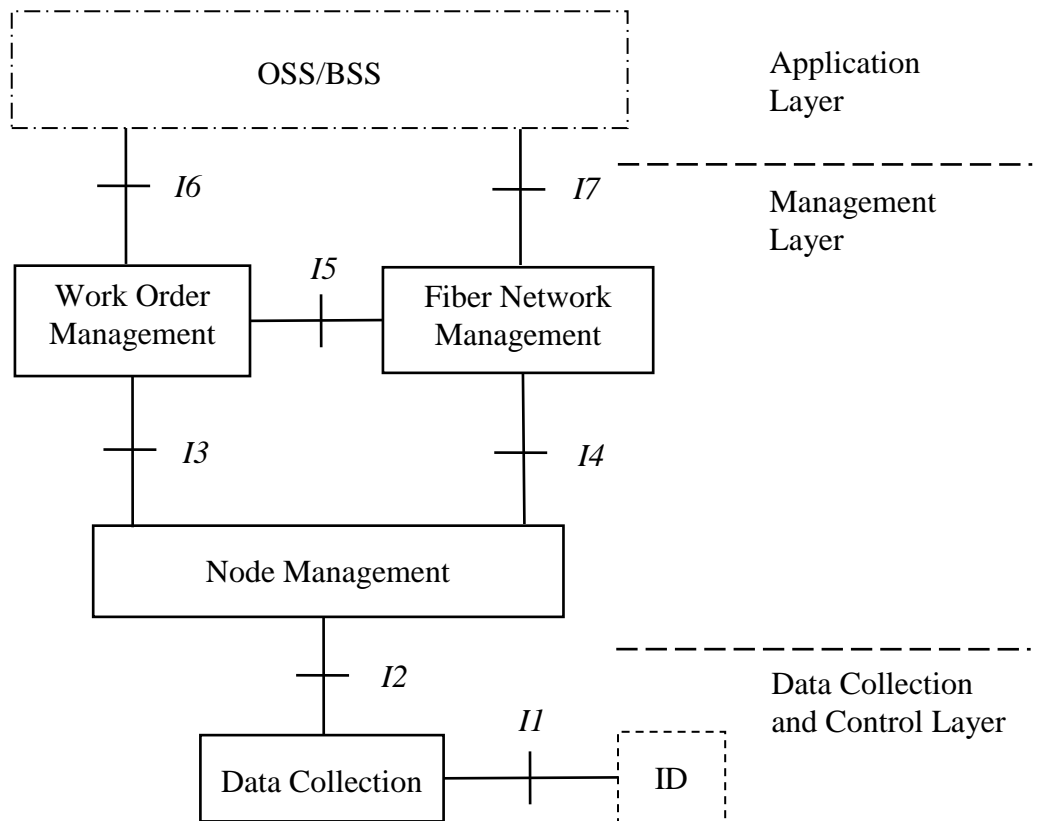
Figure 1 – Functional architecture of fiber infrastructure management system

The Data Collection function collects ID data via I1 interface from the ID block, either automatically activated by monitoring the change of port status (e.g. the change of fiber connection), or triggered by the command(s) from the Management Layer functions. The Data Collection function can also write ID data via I1 interface to the ID block. The Data Collection function generates {port, ID} mapping, which is reported to the Management Layer via I2 interface and used for such Management Layer functions as fiber connection verification. The Data Collection function also controls the port indicator to execute the field operation instructions in accordance with commands from the Management Layer.

The Node Management function serves as a bridge between the Data Collection and Control Layer and the Management Layer. It receives management command and/or configuration information from the Work Order Management function and the Fiber Network Management

function and responds with results via the I3 and I4 interfaces, respectively. It also provides field operation guidance by commanding the Data Collection and Control Layer functions and receiving the corresponding operation result.

The Fiber Network Management function is the core element of the fiber infrastructure management system architecture. It performs the following actions:
* Conducting verification of fiber connection through {port, ID} mapping data;
* Managing the computing and consistency maintenance of end-to-end fiber connection;
* Maintaining resource data related to fiber infrastructure inventory information. The resource data would be the foundation for end-to-end fiber connection computing and verification.
* Maintaining the visual end-to-end fiber network topology associated with GIS-based data for facilitating fiber fault locating and troubleshooting.

Specifically, the Fiber Network Management function serves to synchronize resource data with the OSS/BSS via I7 interface for resource data consistency verification. Also, it communicates with Node Management function via I4 interface.

The Work Order Management function receives the work order request from the OSS/BSS and responds with results via the interface I6. The work order may be sent to the Fiber Network Management function for subsequent end-to-end fiber connection verification and resource data updating process to ensure the consistency of resource data, when necessary, via the interface I5. The Work Order Management function communicates with Node Management function via the interface I3.

The OSS/BSS related to fiber infrastructure management provide applications to a user who wants to use the FIMS to support a variety of operations. This is out of the scope of this document and will not be addressed.

6   Functional Requirements

6.1 Data Collection

The Data Collection function of the FIMS shown in Figure 1 is used to collect ID tag information when port status is changed or the command for resource data collection is received.

In the FIMS, the ID tag is always attached to an optical fiber connector. When an optical fiber connector with an ID tag is present on a port which is used to implement fiber routing, the Data Collection function with port monitoring senses this by reading the tag.

A Missing ID tag indicates that the optical fiber connector is pulled out or dropped from the port under unexpected circumstances. The Data Collection function should be able to detect this unexpected condition and report it as an alarm or event to the upper layer for further processing.

Data Collection function supports the following requirements:

[R-1]   The Data Collection function MUST read information stored in an ID tag when an optical fiber connector with attached ID tag is present on a port.

[R-2]   The Data Collection function SHOULD report the case of a missing ID tag as an event to the Node Management function.

[R-3]   The Data Collection function SHOULD generate a notification to the Node Management function that there is a missing ID tag.

Information stored in the ID tag is one part of the resource data that may include port status and optical node information. The mapping of {port, ID} data reflects the relationship between the optical fiber connector and the port into which the optical fiber connector with the ID tag is plugged. The {port, ID} mapping data will be the fundamental resource data for such actions as fiber connection verification. The Data collection function generates the mapping data of {port, ID} and reports it to the Node Management function.

[R-4]   The Data Collection function MUST read information stored in the ID tag when the command for resource data collection is received from the Node Management function.

[R-5]   It MUST generate mapping relationship between the port ID tag and the connector ID tag.

[R-6]   It MUST report the mapping relationship already generated to the Node Management function.

Besides the mapping data of {port, ID}, resource data in a FIMS also includes optical node, shelf, frame, and line card. All this resource data is collected by the Data Collection function and reported to the upper layer as commanded from the upper layer.

[R-7]   The Data Collection function MUST support receiving a command of resource data collection from the Node Management function.

[R-8]   The Data Collection function MUST collect the port ID tag resource data which may include optical node, frame, shelf, and line card information, and report it to the Node Management function as commanded.

Traditionally in an ODN, field operations are always conducted without any visual guidance. For instance, patch cord connection is dependent on finding the exact ports to be connected by reference to paper records and port labels with high risk of inaccuracy. In the FIMS, field operation guidance is achieved by indicating exact ports to be operated on visually. When receiving the command to commence the field operation guidance, the Data Collection function will initiate the indication of which port to be operated on the field by the use of a visual marker such as lighting an LED light near the port.

[R-9]   The Data Collection function MUST support the receiving of a command of field operation guidance from the Node Management function.

[R-10]   The Data Collection function MUST execute the command of field operation guidance to indicate exact ports to be operated on visually.

[R-11]   The Data Collection function MUST respond to the Node Management function with the field operation result when the field operation is completed.

In some special scenario, e.g. when the Data Collection function fails to read the ID tag because the ID tag is damaged, the Data Collection function may write the current ID tag information into a new ID tag controlled by the Node Management function, and then the current ID tag is replaced with the new one.

[R-12]   Data Collection function MAY write the valid ID tag information to a new ID tag controlled by the Node Management function when the ID tag is damaged or becomes invalid.

6.2 Node Management

The Node Management function shown in Figure 1 serves as a bridge between the Data Collection and Control Layer and the Management Layer, receiving management command(s) for operation from the other management functions, and responding with associated operation result(s). It issues field operation guidance commands to the Data Collection and Control Layer for field operation instruction generation, and receives the corresponding operational result from the Data Collection and Control Layer function. The content of the management command discussed above depends on the operational requirement(s). It may include only one fiber connection information ({port, ID} pair in patch cord connection) for operation, or multiple fiber connection information ({port, ID} pairs for the entire equipment operation) for field efficiency. It supports the following requirements:

[R-13] The Node Management function MUST support sending back the process result from a field operation, including {port, ID} mapping data and/or alarm/event in response to management command(s) for operation received from the Fiber Network Management function, via the interface I4.

[R-14] The Node Management function MUST support receiving the management command(s) from the Work Order Management function via the interface I3, and sending back the process results of the field operation work in response.

[R-15] The Node Management function MUST support issuing field operation commands for further execution instructions to the Data Collection function and receiving the corresponding execution result including resource data as well as an alarm and/or event, from the Data Collection function via the interface I2, according to the received management command(s) referenced in the requirements [R-13] and [R-14].

[R-16] The Node Management function MUST support transferring the alarm and/or event information (initially reported from Data Collection function) to Fiber Network Management function.

[R-17] The Node Management function SHOULD support the storing, importing and exporting information required during a field operation.

[R-18] The Node Management function SHOULD support visualization method(s) / approach(es) for field operation guidance.

In order to ensure validity of the ID tag information before the Data Collection function writes the existing ID tag information into a new ID tag, the Node Management function extracts the accurate current ID tag information from the resource data stored in the Fiber Network Management function.

[R-19] The Node Management function MUST be able to extract existing ID tag information from the resource data stored in the Fiber Network Management function.

6.3 Fiber Network Management

Fiber Network Management, as shown in Figure 1, is the core function of Management Layer. It involves the end-to-end fiber routing management and its related resource data management. It supports the following requirements:

[R-20] The Fiber Network Management function MUST support a northbound interface I7 to OSS/BSS.

[R-21] The Fiber Network Management function MUST support resource data synchronization with OSS/BSS via the I7 interface.

[R-22] The Fiber Network Management function MUST support an interface I5 to the Work Order Management function.

[R-23] Functionality related to the interface I5 SHOULD include end-to-end optical fiber routing computation and resource data verification.

[R-24] The Fiber Network Management function MUST support an interface I4 to the Node Management function.

[R-25] Functionality related to the interface I4 MUST include receiving resource data as well as alarm and/or event reported from the Data Collection function via the Node Management function.

Resource data management is an essential element of the Fiber Network Management function. All resource data maintained in the Fiber Network Management function is used to implement fiber connection verification and end-to-end fiber routing management.

[R-26] The Fiber Network Management function MUST support receiving resource data reported from the Data Collection function via the Node Management function.

[R-27] The Fiber Network Management function MUST support resource data storage.

[R-28] Objects for resource data stored in the Fiber Network Management function SHOULD include, but not limited to, labels for optical nodes, frames, shelves, line cards, ports, optical components such as splitters, and port ID / connector ID tag pair data.

[R-29] The Fiber Network Management function MUST support resource data verification in order to maintain the consistency of the stored resource data with the actual field resource data.

[R-30] The Fiber Network Management function MUST support resource data inquiry.

[R-31] The Fiber Network Management function SHOULD support resource data backup and restoration.

[R-32] The Fiber Network Management function SHOULD support access control to the resource data.

Fiber connection always means that a patch cord with electronic ID tag is used to connect two ports to implement fiber routing scheduling when a field operation is conducted. For a specific patch cord, the identity information for each fiber connector with attached electronic ID tag is the same. Therefore, the port connection by patch cord can be verified by using {port, ID} mapping data reported from the Data Collection function via the Node Management function.

[R-33] The Fiber Network Management function MUST support automated fiber connection verification by using {port, ID} mapping data reported from the Data Collection function via the Node Management function.

[R-34] The Fiber Network Management function SHOULD support visual end-to-end fiber network topology generation associated with the GIS-based data for facilitating optical fiber fault locating and troubleshooting.

[R-35] The Fiber Network Management function MUST support end-to-end optical fiber routing computation according to the starting-point and ending-point information and resource data maintained.

[R-36] The Fiber Network Management function MUST support an end-to-end optical fiber routing information inquiry.

[R-37] The Fiber Network Management function MUST support managing alarms and/or events related to optical fiber connection such as disconnection of patch cord, misconnection of fiber connector.

[R-38] The Fiber Network Management function SHOULD support statistical analysis for optical fiber information such as optical fiber usage.

6.4 Work Order Management

The Work Order Management function shown in Figure 1 is used to manage work orders.

The Work Order Management function receives a work order from OSS/BSS, and then processes it. If the work order does not include fiber routing information, the Work Order Management function asks the Fiber Network Management function for end-to-end fiber routing computation. Otherwise, the Work Order Management function sends a command to the Node Management function, and notifies the Fiber Network Management function of the relevant fiber routing information. The Work Order Management function determines the completion of the work order by two conditions: the work order execution result reported by the Node Management function, and the resource verification result provided by the Fiber Network Management function. Finally, the Work Order Management function reports the result to OSS/BSS.

The Work Order Management function supports the following requirements:

[R-39] The Work Order Management function MUST support receiving work order from OSS/BSS via I6 interface.

[R-40] The Work Order Management function MUST support processing work order and sending commands to the Node Management function via I3 interface and/or the Fiber Network Management function via I5 interface in accordance with the work order information.

[R-41] The Work Order Management function SHOULD support sending commands to the Fiber Network Management function for an end-to-end fiber routing computation and resource data verification, when necessary, via the interface I5.

[R-42] The Work Order Management function MUST support reporting the result back to OSS/BSS when a work order is completed.

[R-43] The Work Order Management function SHOULD support the work order log inquiry and export.

[R-44] The Work Order Management function SHOULD support capability for visual display of work orders.

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7   Description of Interfaces

7.1 I1: ID Tag - Data Collection Interface

This section describes the functionality and parameters relevant to the I1 interface.

The I1 interface links the ID tag with the Data Collection function. The Data Collection function reads the information stored in the ID tag when an optical fiber connector with attached ID tag is plugged into a port, or when the command for resource data collection is received from the Node Management function. Thus, this interface is not a transactional interface, and it serves to support the information reading action by the Data Collection function.

7.2 I2: Data Collection - Node Management Interface

This section describes the functionality and parameters relevant to the I2 interface.

The I2 interface is between the Data Collection function and the Node Management function. This interface serves to support the following two actions by the Node Management function:

1) Issuing field operation guidance commands to the Data Collection function to guide the patch cord connection operation (hereafter, to be called field operation) by a field installer (technician). In the following table, this action/functionality is shown as "Issue Command for Field Operation Guidance". This action is called for by management command(s) from the Work Order Management function. The Node Management function receives field operation result(s) from the Data Collection function upon completion of the field operation execution of the guidance command.

2) The Node Management function issues the ID data writing command to the Data Collection function. In the following table, this action/functionality is shown as "Issue Command to write ID data". The Node Management function receives the ID data writing command execution result from the Data Collection function upon the completion of the writing ID data execution. The I2 interface also serves to convey alarms and/or events from Data Collection function to the Node Management function as described in the third row of the table shown below.

[R-45]   The I2 interface MUST support the following functionality/action and parameters.

Functionality/Action	Initiated by	Parameters	Response
Issue Command for Field Operation Guidance	Node Management function	Operation objects (optical node, shelf, frame, line card, port, {port, ID} connection pair(s).)	Field operation result with resource data and/or event/alarm

Issue command to write ID data	Node Management function	Valid ID tag information	The result of the processing of the command (e.g., success or failure)
Report alarm/event	Data Collection function	Alarm/event (e.g. missing ID tag)	Not necessary

7.3 I3: Node Management - Work Order Management Interface

This section describes the functionality and parameters relevant to the I3 interface.

I3 interface links the Node Management function to the Work Order Management function. The Work Order Management function processes a work order, and then sends commands to the Node Management function via I3 interface. The Node Management function processes the commands and sends back the result to the Work Order Management function via I3 interface.

[R-46]   The I3 interface MUST support the following functionality/action and parameters.

Functionality/Action	Initiated by	Parameters	Response
Send work order execution command to Node Management	Work Order Management	Operation related to work order (e.g. patch cord operation)	Not necessary
Report the result of command processing to Work Order Management	Node Management	The result of command processing (e.g., success or failure)	Not necessary

7.4 I4: Node Management - Fiber Network Management Interface

This section describes the functionality and parameters relevant to the I4 interface.

The I4 interface links the Node Management function to the Fiber Network Management function. The Node Management function reports resource data as well as alarm(s)/event(s) originating from the Data Collection function to the Fiber Network Management function via the I4 interface while the Fiber Network Management function sends command(s) to the Node Management function for initiating resource data collection. The Node Management function also requests that the Fiber Network Management function send the valid ID tag data before the writing ID data command is executed.

[R-47]   The I4 interface MUST support the following functionality/action and parameters.

Functionality/Action	Initiated by	Parameters	Response
Reporting resource data	Node Management	Resource data (e.g. {port, ID}, optical node, frame, shelf, line card, port, port status, etc.)	Not necessary
Reporting alarm/event	Node Management	Alarm/event (e.g. missing ID tag)	Not necessary
Commanding resource data collection	Fiber Network Management	None	Resource data returned
Request ID data	Node Management	Port information (e.g., optical node, frame, shelf, line card, port, etc.)	Valid ID tag information

7.5 I5: Work Order Management - Fiber Network Management Interface

This section describes the functionality and parameters relevant to the I5 interface.

The work order for service provisioning originates from OSS/BSS. The parameters of the work order for service provisioning from OSS/BSS are always dependent on the OSS/BSS system deployed by a service provider. The work order parameters may include only the start-point and end-point information for service provisioning. In this case, the Work Order Management function sends messages to the Fiber Network Management function to request computation of a best case integrated end-to-end fiber routing information, and, then, generates operation work order(s) with such information as patch cord connection. However, the work order parameters may also include detailed fiber routing information related to service provisioning. In this case, the Work Order Management function sends messages to notify the Fiber Network Management function of the resource data relevant to the detailed fiber routing information for the resource data verification.

When the field operation guided by a work order is completed, the resource data is always collected, and, reported to the Fiber Network Management function for resource data verification. Upon completion of the resource data verification process, the result is sent to the Work Order Management function to confirm the satisfactory execution of the work order.

[R-48]   The I5 interface MUST support the following functionality/action and parameters.

Functionality/Action	Initiated by	Parameters	Response
Request computing an end-to-end optical fiber routing	Work Order Management	Start-point, End-point	Detailed fiber routing information
Notify the Fiber Network Management function of the resource data to be used for the detailed fiber routing information	Work Order Management	Resource data relevant to the detailed fiber routing information	Not necessary
Notify the Work Order Management function of the result of resource data verification	Fiber Network Management	Result of resource data verification	Not necessary

7.6 I6: Work Order Management Northbound Interface

This section describes the functionality and parameters relevant to the I6 interface.

The I6 interface is the Work Order Management northbound interface. The Work Order Management function receives a work order from the OSS/BSS via the I6 interface. When a work order is completed, the Work Order Management function reports the result to the OSS/BSS via the I6 interface.

[R-49]   The I6 interface MUST support the following functionality/action and parameters.

Functionality/Action	Initiated by	Parameters	Response
Send a work order to the Work Order Management	OSS/BSS	Work order information (e.g., patch cord operation work order)	Not necessary
Report the result of work order execution to the OSS/BSS	Work Order Management	The result of work order execution (e.g., success or failure)	Not necessary

7.7 I7: Fiber Network Management Northbound Interface

This section describes the functionality and parameters relevant to the I7 interface.

The I7 interface is the northbound interface for Fiber Network Management function to implement resource data synchronization/updating with the OSS/BSS. The Fiber Network Management function maintains the resource data collected automatically from the Data Collection function as

well as the resource data synchronized/updated with the OSS/BSS. In addition, the Fiber Network Management function reports the resource data collected automatically to the OSS/BSS for automated resource data updating.

[R-50]   The I7 interface MUST support the following functionality/action and parameters relevant to the I7 interface.

Functionality/Action	Initiated by	Parameters	Response
Notification of change in resource data	Fiber Network Management	None	Not necessary
Request resource data	OSS/BSS	None	Send resource data
Reporting resource data to the OSS/BSS	Fiber Network Management	Resource data	Not necessary

Appendix I   Fiber Infrastructure Management System Use Cases

This Appendix contains informative FIMS use cases.
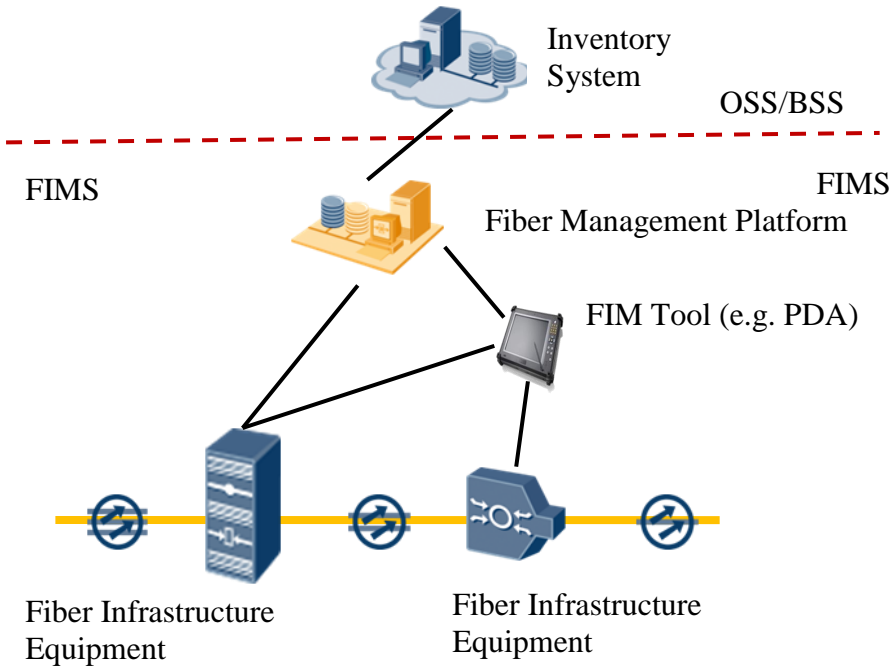
In order to facilitate a better understanding of use cases, the following schematic representation shows an implementation architecture model of fiber infrastructure management system.
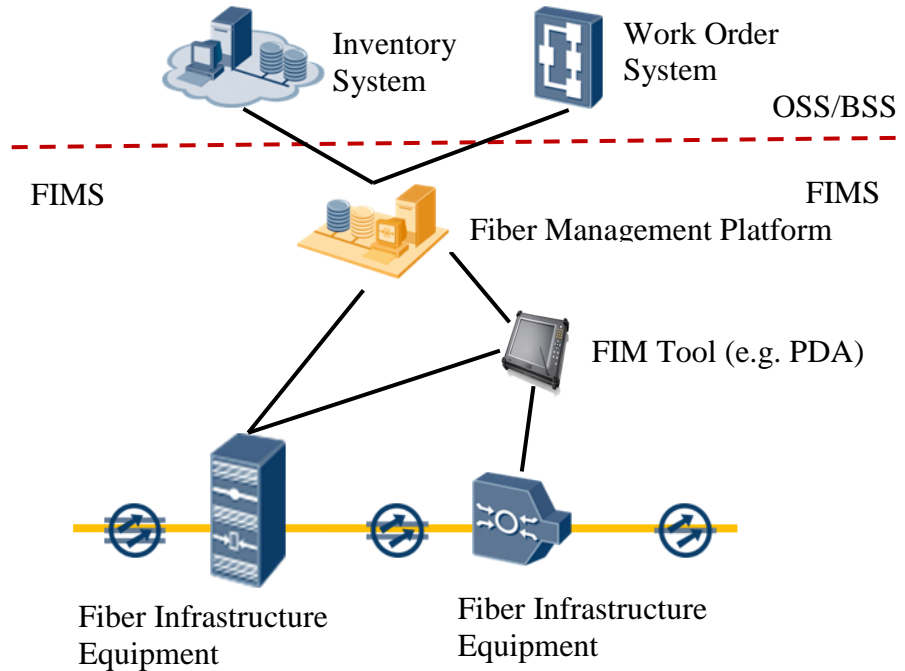
Figure 2 – An implementation architecture model of the FIMS

• Fiber Infrastructure Equipment: An implementation of an optical node with added functions such as collecting and reporting resource data automatically, monitoring port status to sense the patch cord connection, indicating correct port visually to guide field operation.
• Fiber Infrastructure Management Tool: A portable device which is used to assist field operation. It serves as a communications proxy for the Fiber Infrastructure Equipment which has no capability of connecting to the Fiber Management Platform directly. Also, it can provide power for the Fiber Infrastructure Equipment when a field operation is conducted.
• Fiber Management Platform: A Computing platform that implements the FIMS Management Layer functions.
• Inventory System: A subsystem of the OSS/BSS, which is used to store and manage resource data not only from a FIMS, but also from other parts of an optical fiber network.
• Work Order System: A subsystem of the OSS/BSS, where work orders for the FIMS are initiated.
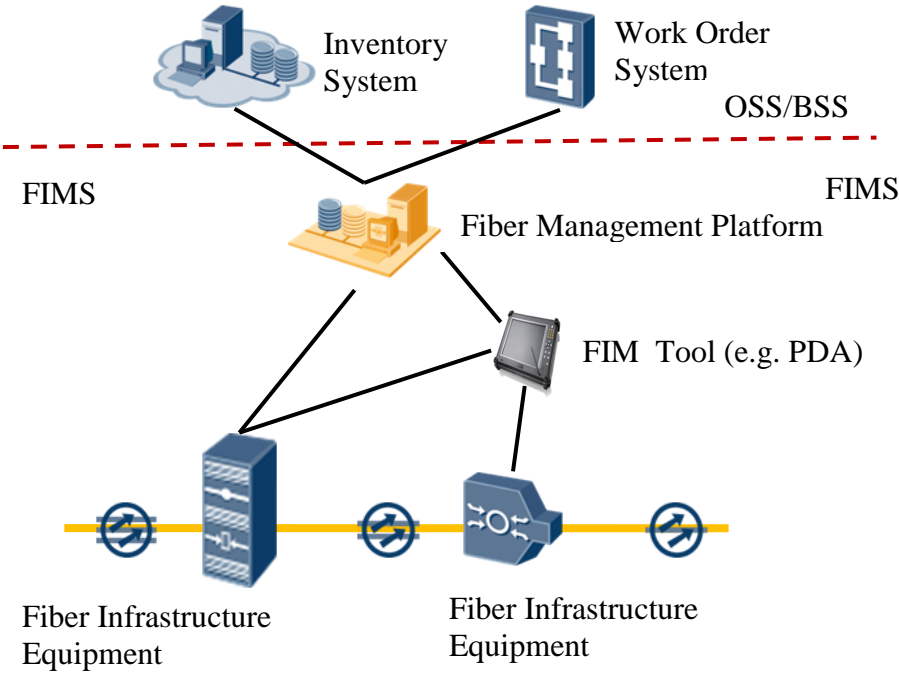
1.   Installation

Title	Installation: Initial Resource Data Collection and Verification
Actors	Service Provider Field Operator
Scope	Fiber Infrastructure Management System OSS/BSS
Story	After a service provider completes planning and design of a FIMS, Fiber Infrastructure Equipment is installed and configured accordingly. Then, the Fiber Infrastructure Equipment is discovered, and its initial resource data is uploaded in an automated process. For the uploaded resource data, a Fiber Management Platform provides storage and verification capabilities, and it enables synchronization/updating to the Inventory system(s) for further processing in the OSS/BSS.
Architectural context	This scenario is illustrated below. In this example, the FIMS implements resource data storage, verification and synchronization/updating to the Inventory system. Fiber Infrastructure Management Tool (e.g. PDA) implements communications proxy for Fiber Infrastructure Equipment which has no capability of connecting to the Fiber Management Platform directly. The Fiber Infrastructure Equipment enables the resource data collection and reports the full resource data to the Fiber Management Platform, which conducts verification and synchronization / updating of the resource data to the Inventory System in the service provider's OSS/BSS.

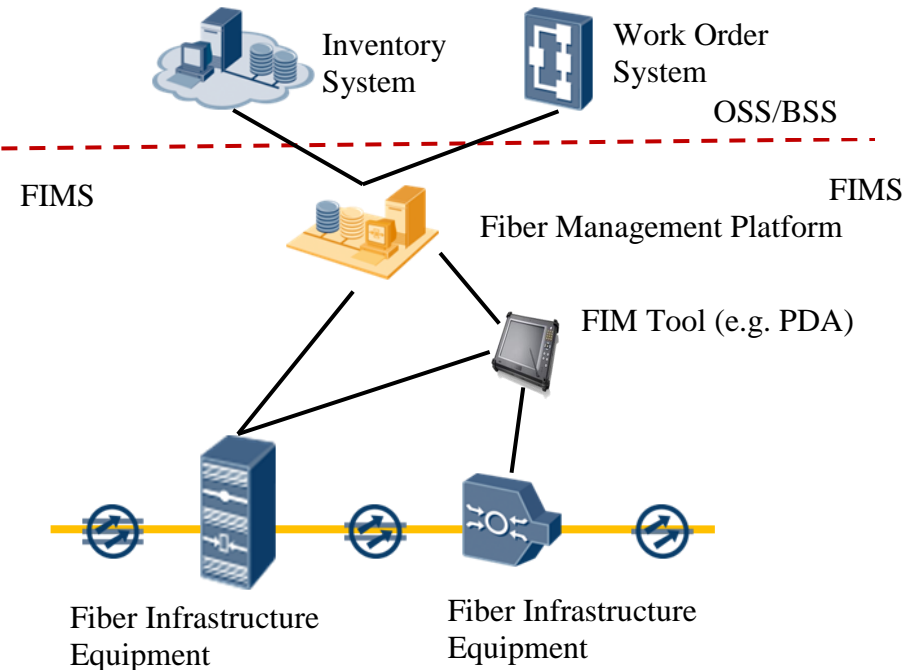| Business Drivers	In ODN systems, initial resource data is always uploaded to the Inventory system manually without verification, and, therefore, with low efficiency and high risk of inaccuracy.
Related SDO Efforts	None
Related Use Cases	None specific.

2.   Service Provisioning

Title	Service Provisioning: Patch Cord Connection
Actors	Service Provider

Field Operator |
| Scope | Fiber Infrastructure Management System

OSS/BSS |
| Story | When the task of service provisioning starts, it always involves the patch cord connection operation. Therefore, the Work Order System in the OSS/BSS downloads the work order to the Fiber Management Platform which processes the work order and sends the command for field operation guidance (e.g. lighting the LED port indicator) to Fiber Infrastructure Equipment. Then, a field operator carries out the patch cord connection operation according to the guidance. When the field operation is completed, the Fiber Infrastructure Equipment reports the added resource data to the Fiber Management Platform for patch cord connection verification and resource data synchronization/updating with the Inventory System in the OSS/BSS. |
| Architectural context | This scenario is illustrated below. |

<table>
<tr><td></td><td>In this example, the Fiber Management Platform implements work order processing, generating command(s) for field operation guidance, patch cord connection verification and resource data synchronization/updating. The Fiber Infrastructure Management Tool (e.g. PDA) provides communications proxy for the Fiber Infrastructure Equipment which has no capability of connecting to the Fiber Management Platform directly. The Fiber Infrastructure Equipment enables the field operation guidance and reports the added resource data.</td></tr>
<tr><td>**Business Drivers**</td><td>For ODN systems, Service Provisioning is always driven by work orders on paper with low efficiency and high risk of error. When a field operation is completed, verification and resource data updating are conducted manually with low efficiency and high risk of inaccuracy.</td></tr>
<tr><td>**Related SDO Efforts**</td><td>ITU-T Rec. L.64</td></tr>
<tr><td>**Related Use Cases**</td><td>None specific.</td></tr>
</table>

3.   Resource Inventory and Verification
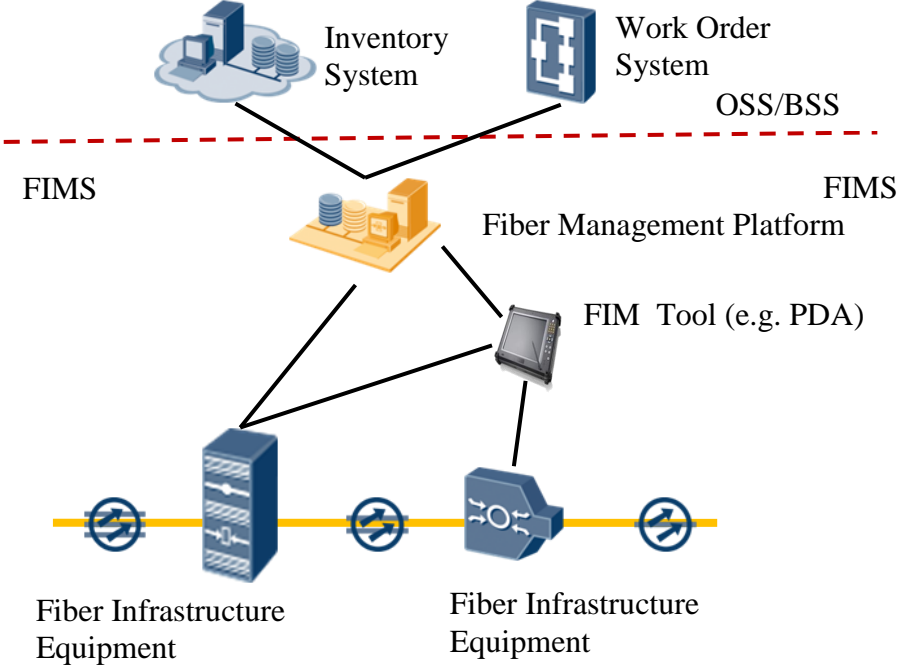
Title	Resource Inventory and Verification: Periodic Resource Data Consistency Check
Actors	Service Provider Field Operator
Scope	Fiber Infrastructure Management System

	OSS/BSS
Story	A Service provider always needs to conduct resource data consistency check periodically in order to ensure the consistency of resource data. When the task of resource data consistency check starts, the Work Order System in the OSS/BSS downloads the work order to the Fiber Management Platform which processes the work order and sends the command to the Fiber Infrastructure Equipment. The Fiber Infrastructure Equipment uploads the full resource data to the Fiber Management Platform for resource data consistency check and synchronization/updating to the Inventory System in the OSS/BSS.
Architectural context	This scenario is illustrated below. In this example, the Fiber Management Platform implements work order processing, command generating, resource data consistency check and resource data synchronization / updating. The Fiber Infrastructure Management Tool (e.g. PDA) provides communications proxy for the Fiber Infrastructure Equipment which has no capability of connecting to the Fiber Management Platform directly. The Fiber Infrastructure Equipment enables the resource data collection and reports the full resource data to the Fiber Management Platform for verification and synchronization / updating of the resource data to the Inventory System in the service provider's OSS/BSS.
Business Drivers	For ODN systems, periodic resource data consistency check is always driven by work orders on paper with low efficiency and high risk of error. Resource data updating and consistency check are conducted manually with low efficiency and high risk of inaccuracy.
Related SDO	None

Efforts	
Related Use Cases	None specific.

4.   Troubleshooting and Fault Locating

Title	Troubleshooting and Fault Locating: Optical Fiber Re-routing
Actors	Service Provider Field Operator
Scope	Fiber Infrastructure Management System OSS/BSS
Story	When a trouble report is received from a customer, the fault management process is initiated. In this case, one or more changes in optical fiber connection need to be considered in specific Fiber Infrastructure Equipment. In accordance with the fault management process, a work order is dispatched to a field operator who carries a Fiber Infrastructure Management Tool. The Field operator uses the Fiber Infrastructure Management Tool to inquire about available resource data for optical fiber re-routing. Then, the field operator carries out the optical re-routing operation under visual guidance. When the field operation is completed, the Fiber Infrastructure Equipment reports the added/changed resource data from the Fiber Infrastructure Equipment to the Fiber Management Platform for resource data verification and synchronization/updating with the Inventory System in service provider's OSS/BSS.

| Architectural context	This scenario is illustrated below.
	In this example, the Fiber Management Platform implements work order dispatching to the Fiber Infrastructure Management Tool, enquiry of available resource data, resource data verification and synchronization / updating to the OSS/BSS. The Fiber Infrastructure Management Tool (e.g. PDA) is used to inquire about the available resource data for optical fiber re-routing and provides communications proxy for the Fiber Infrastructure Equipment which has no capability of directly connecting to the Fiber Management Platform. The Field operator executes the field operation using the visual guidance. Then, the Fiber Infrastructure Equipment reports the field operation results (additions/changes in resource data) automatically.
Business Drivers	For ODN systems, enquiry of available resource data for optical fiber re-routing is not possible in the field. Thus, after the optical fiber re-routing is conducted, the resource data updating and consistency check are done manually with low efficiency and high risk of inaccuracy.
Related SDO Efforts	None
Related Use Cases	None specific.

Appendix II   Potential Implementation and Deployment Scenarios for Fiber Infrastructure Management Systems

This Appendix contains informative potential implementation and deployment scenarios.
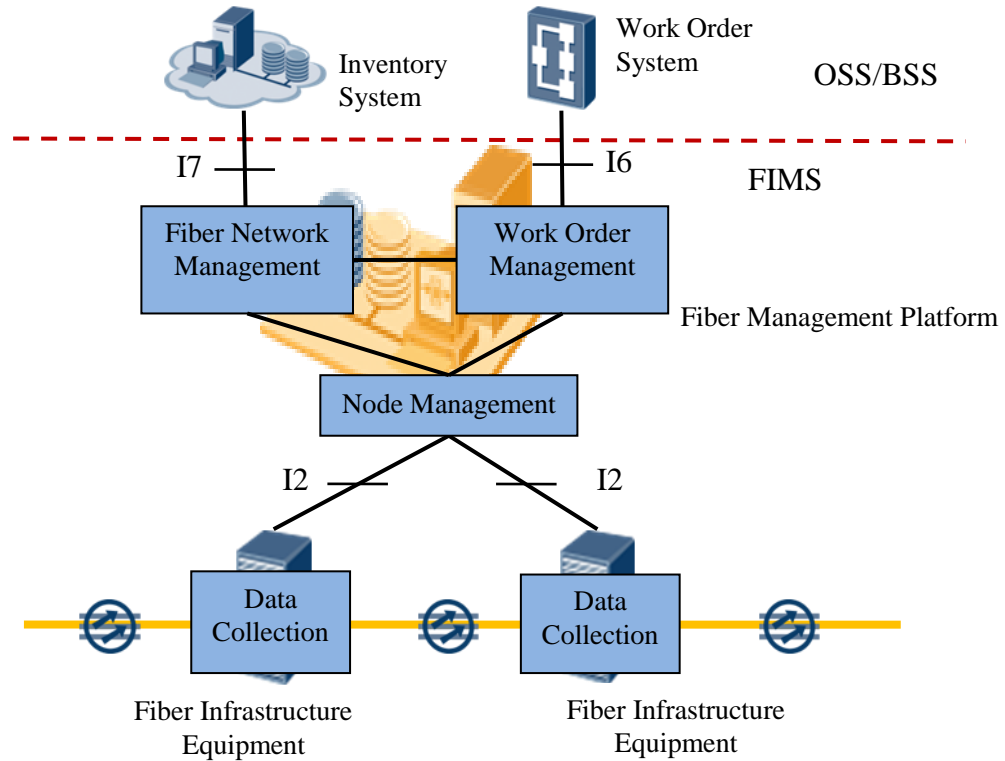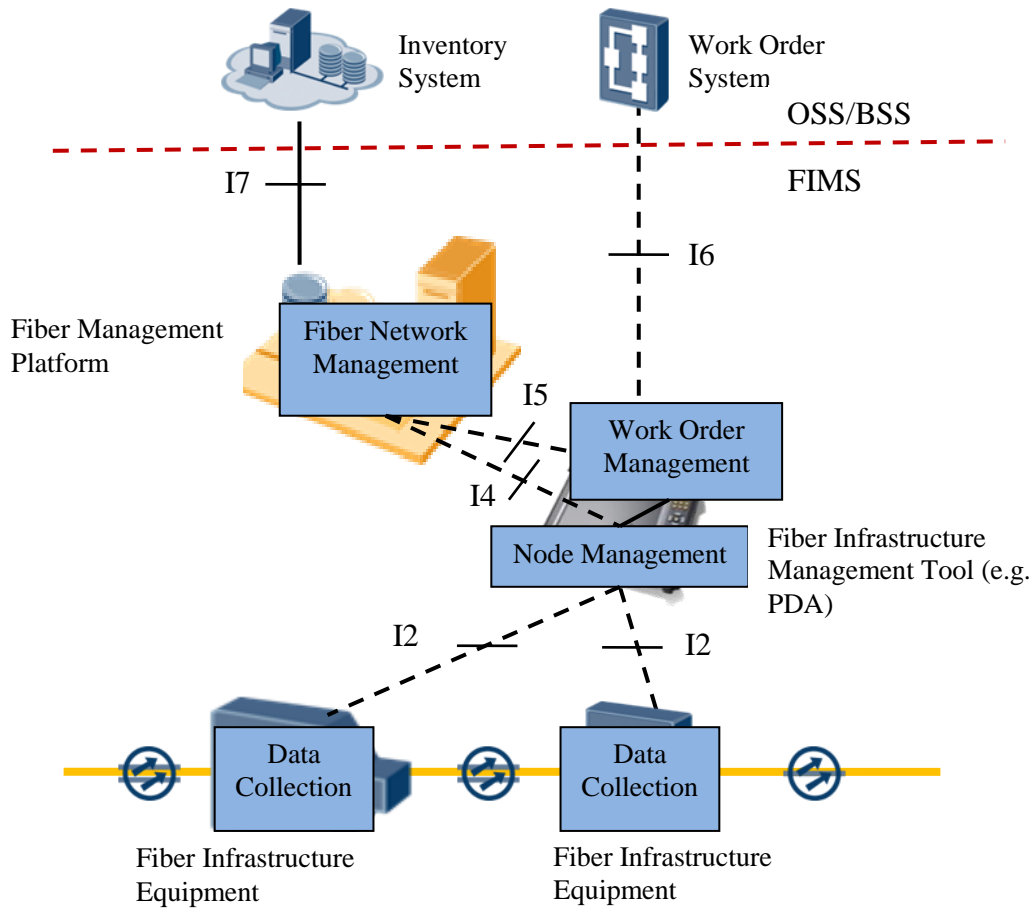

Figure 3 – On-line management of the Fiber Infrastructure Equipment

Figure 3 shown above depicts an **on-line management scenario** where the Work Order Management, Fiber Network Management, and Node Management functional blocks are located within the same physical Fiber Management Platform while the Data Collection functional block is located within the physical unit(s) of the Fiber Infrastructure Equipment. This scenario is applicable in Central Offices where Fiber Infrastructure Equipment can be managed on line and monitored by the Fiber Management Platform. In this scenario, work orders are processed by the Fiber Management Platform, and, then, command for field operation guidance is issued directly to the Fiber Infrastructure Equipment to guide the field operation (e.g. patch cord connection). Moreover, the Fiber Infrastructure Equipment senses the changes of state of the resource data, collects the new resource data, and directly reports the data collected to the Fiber Management Platform for resource data verification and updates.
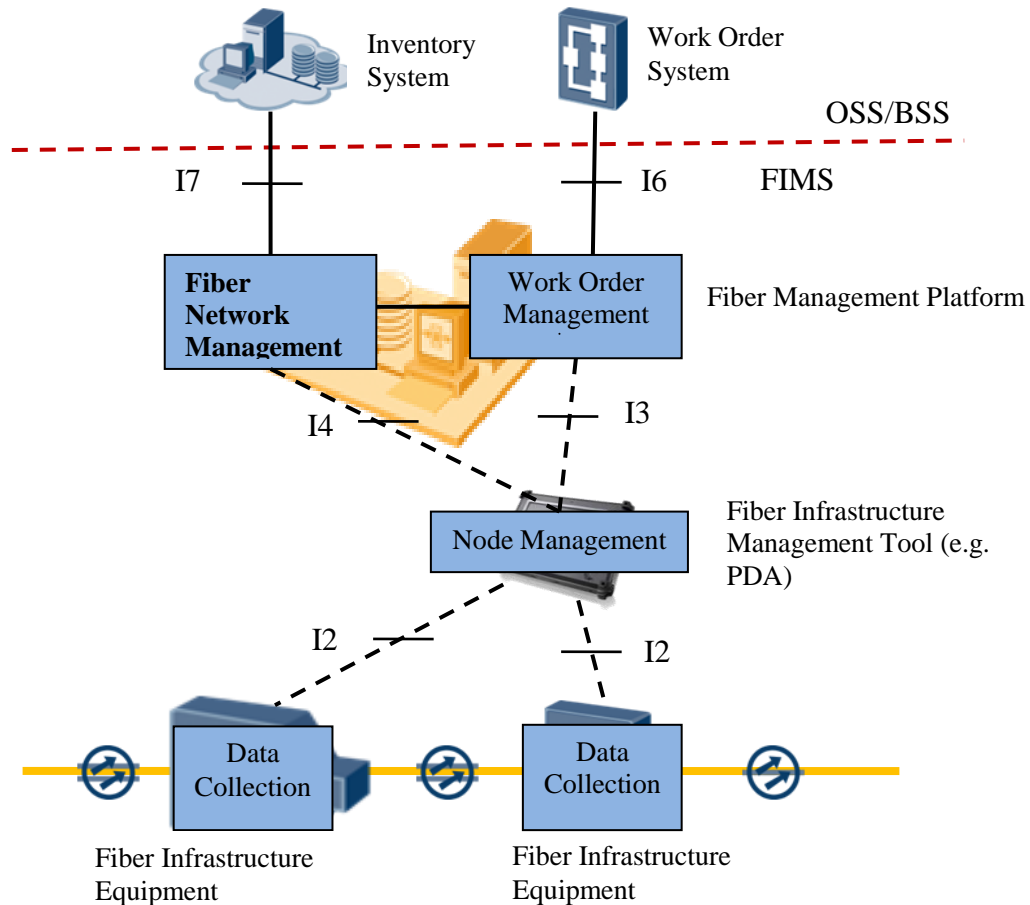
Figure 4 – Off-line management of the Fiber Infrastructure Equipment

Figure 4 shown above depicts an **off-line management scenario** where the Work Order Management and Fiber Network Management functional blocks are located within the same physical Fiber Management Platform while the Node Management functional block is located within the physical Fiber Infrastructure Management Tool (e.g. PDA), and the Data Collection function is located within physical unit(s) of the Fiber Infrastructure Equipment. In this figure, the dashed lines represent non-permanent connections/interfaces. This scenario is applicable to the ODN outside plant where the Fiber Infrastructure Equipment can be managed off line and monitored by the Fiber Management Platform with the assistance of the Fiber Infrastructure Management Tool. In this scenario, work orders are processed by the Fiber Management Platform and command to guide the field operation (e.g. patch cord connection) is issued to the Fiber Infrastructure Equipment with the assistance of the Fiber Infrastructure Management Tool. Moreover, the Fiber Infrastructure Equipment senses the changes of state of the resource data, collects the new resource data and reports the data collected to the Fiber Management Platform with the assistance of the Fiber Infrastructure Management Tool for resource data verification and updating.

Figure 5 – A Variation on off-line management of the Fiber Infrastructure Equipment

Figure 5 shown above depicts a **variation on the off-line management scenario** where the Fiber Network Management function is located within the physical Fiber Management Platform while the Work Order Management and Node Management functions are located within the physical Fiber Infrastructure Management Tool (e.g. PDA), and the Data Collection functional block is located within physical unit(s) of Fiber Infrastructure Equipment. In this figure, the dashed lines represent non-permanent connections/interfaces. In this scenario, a work order is downloaded from the OSS/BSS and processed by the Fiber Infrastructure Management Tool, and commands to guide the field operation (e.g. patch cord connection) are issued to the Fiber Infrastructure Equipment. Moreover, the Fiber Infrastructure Equipment senses the changes of state of the resource data, collects the new resource data, and reports the resource data collected to the Fiber Management Platform with the assistance of the Fiber Infrastructure Management Tool for resource data verification and updating.

End of Broadband Forum Technical Report TR-311