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SERIES L: CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

## ID tag requirements for infrastructure and network elements management

ITU-T Recommendation L.64

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## ID tag requirements for infrastructure and network elements management


**Summary**

Telecommunication networks require proper allocation of network elements and planned periodical maintenance to deliver services quickly and efficiently, to minimize out-of-service risk and to guarantee service level agreement satisfaction. It is particularly important to focus on the issue of optical fibre-based infrastructures and the related huge amount of transmitted information. Network elements that undergo allocation and maintenance operations can be of several types and can differ in terms of position, dimensions, services, field work and scheduled times for periodical planned maintenance.

Identification data (ID) technology can be applied to solutions that focus on the proper management of infrastructure and network elements. The ID uniquely identifies an element of interest in terms of its allocation and maintenance.



**Source**

ITU-T Recommendation L.64 was approved on 6 February 2007 by ITU-T Study Group 6 (2005-2008) under the ITU-T Recommendation A.8 procedure.

## FOREWORD

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## CONTENTS

# ITU-T Recommendation L.64

## ID tag requirements for infrastructure and network elements management

### 1 Scope

This Recommendation deals with support systems for infrastructure and network elements management using ID technology for telecommunication networks. In particular, it points out criteria for ID tag design in order to be adapted to different applications' requirements.

### 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.

[ISO/IEC 15394] ISO/IEC 15394:2000, *Packaging – Bar code and two-dimensional symbols for shipping, transport and receiving labels*.

[ISO/IEC 15438] ISO/IEC 15438:2006, *Information technology – Automatic identification and data capture techniques – PDF417 Bar code symbology specifications*.

[ISO/IEC 16022] ISO/IEC 16022:2006, *Information technology – Automatic identification and data capture techniques – Data Matrix bar code symbology specification*.

[ISO/IEC 18000-1] ISO/IEC 18000-1:2004, *Information technology – Radio frequency identification for item management – Part 1: Reference architecture and definition of parameters to be standardized*.

[ISO/IEC 18000-2] ISO/IEC 18000-2:2004, *Information technology – Radio frequency identification for item management – Part 2: Parameters for air interface communications below 135 kHz*.

[ISO/IEC 18000-3] ISO/IEC 18000-3:2004, *Information technology – Radio frequency identification for item management – Part 3: Parameters for air interface communications at 13.56 MHz*.

[ISO/IEC 18000-4] ISO/IEC 18000-4:2004, *Information technology – Radio frequency identification for item management – Part 4: Parameters for air interface communications at 2.45 GHz*.

[ISO/IEC 18000-6] ISO/IEC 18000-6:2004, *Information technology – Radio frequency identification for item management – Part 6: Parameters for air interface communications at 860 MHz to 960 MHz*.

[ISO/IEC 18004] ISO/IEC 18004:2006, *Information technology – Automatic identification and data capture techniques – QR Code 2005 bar code symbology specification*.

## 3 Definitions

For the purpose of this Recommendation, the definitions given in [ISO/IEC 15394], [ISO/IEC 15438], [ISO/IEC 16022], [ISO/IEC 18000-1], [ISO/IEC 18000-2], [ISO/IEC 18000-3], [ISO/IEC 18000-4], [ISO/IEC 18000-6] and [ISO/IEC 18004] apply.

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

| | |
|---|---|
| GSM | Global System for Mobile communication |
| HF | High Frequency |
| ID | Identification Data |
| ISM | Industrial, Scientific, Medical |
| LAN | Local Area Network |
| LF | Low Frequency |
| MTBF | Mean Time Between Failures |
| OSS | Operations Support System |
| PDA | Personal Digital Assistant |
| QR | Quick Response |
| RFID | Radio Frequency Identification |
| UHF | Ultra High Frequency |

## 5 Conventions

*None.*

## 6 Identification data

### 6.1 General requirements for ID

1) ID should be unique.
2) ID should be capable of being read easily.
3) ID should be capable of being input into an OSS when intended target elements are installed and when they are connected or disconnected.
4) ID should not include facility information. ID should only have information that can be converted to facility information in the facility database over an OSS.

### 6.2 ID tag

ID tags are ready to be mounted on the network element or already provided as an embedded tag.

They should be permanently mounted on the network element or in such a manner that makes them difficult to remove.

#### 6.2.1 RFID tag

RFID tags usually consist of three parts: chip, antenna and case. They are different for several sets of features: physical, electrical, chemical, mechanical and thermal characteristics. Since in network telecommunication infrastructure and network elements the environmental conditions are quite different, it is impossible to define a unique kind of RFID tag suitable for all the applications.

Consideration is needed in order to provide an appropriate solution or solutions for differing networking element ID requirements.

Appropriate applications for RFID are where hostile environments affect long-term durability and readability of visible text or barcode data and/or ID data set is large.

#### 6.2.1.1 Frequency

The frequency spectrum available for in-field implementation is not homogenous worldwide.

LF band (less than 135 kHz) is recommended for traditional RFID application where low transfer rate and small tag memory are acceptable. It is recommended to check for presence of other technologies in the same band (i.e., ISDN transmission).

ISM HF band (13.56 MHz) is recommended for short-range RFID applications and provides excellent immunity to environmental noise and electrical interference. This is the typical condition in maintenance activities where reader antennas can be moved very close to the tag. It is recommended to check for presence of other technologies in the same band (i.e., VDSL plan 998).

UHF band (860-960 MHz) is recommended for logistic applications where fixed antennas must read moving tags automatically and anti-collision for parallel tag reading must be supported. It is recommended to check for presence of other technologies in the same band (i.e., GSM).

ISM microwave band (2.45 GHz) is recommended for long-range applications where, for security reasons or other causes, tags cannot be directly attached to the network element or direct access to network element/tag must be avoided. It is recommended to check for presence of other technologies in the same band (i.e., wireless LAN).

#### 6.2.1.2 Power supply

In short-range applications (LF and HF bands), the use of maintenance-free passive tags (no battery) is recommended. In long-range applications (UHF and microwave bands), (semi-)active tags are typically used in order to achieve transmission between tag and reader.

#### 6.2.1.3 Transmission distance

In short-range applications (LF and HF bands) transmission distance is not an issue, although metallic substrates can greatly reduce read distance unless compensatory tuning is applied to tags. It is recommended that the tag be readable even through a protective plastic cover, where one is present. Short-range transmission at 13.56 MHz requires a low force magnetic field that causes no disturbance to other circuits and which avoids undesired tag reading (this needs testing/confirmation that there is no interference risk to VDSL, especially plan 998-12 MHz used in USA).

In long-range applications (UHF and microwave bands) it is recommended to check for possible interference in the wave propagation direction.

#### 6.2.1.4 Tag reading discrimination

Tags situated in very close proximity to each other can result in misreading the intended individual tag and capturing an adjacent tag. This situation can readily arise with cable sheaths in congested areas. Consideration should be given to appropriate designs of scanning head/antenna to eliminate this risk.

#### 6.2.1.5 Data storage

It is recommended that the RFID tag be provided with a non-volatile memory chip embedded. Memory must be sized in order to store all appropriate information. The data structure should be determined by users for their applications.

It is recommended that memory is readable and writable in order to allow upgrade of the content as a result of maintenance actions.

In presence of confidential data stored on the tag, it is recommended to consider and solve security issues.

Data stored on the tag can be used to certify in-field activity deployment.

Data stored on the tag allow in-field operators to retrieve information.

#### 6.2.1.6 Case

The tag case performs the double function of chip protection and tag adaptation to the network element where it must be attached.

It is recommended that new network elements be supplied with an embedded tag. This solution facilitates and quickens the deployment of the RFID-based network element management system.

This may require development of new design solutions to allow for integration in cables. This solution should reduce the risks to operators of protruding tags.

In indoor applications it is recommended that the RFID tag case provides protection against water and dust and that it remains readable if mounted on a metal surface.

In outdoor applications it is recommended that the RFID tag case provides protection against water, dust and UV rays and that it remains readable if mounted on a metal surface. Mechanical impact and crush resistance is required for external use, such as underground joint housings, where they may be stood on.

Consideration should be given to protection from electromagnetic trauma such as lightning strikes, and ensuring adequate isolation from any electrical ground path.

In particular environmental conditions where chemical substances are present, further protection is recommended.

The use and design of stand-alone tags should consider the safety of operators from protrusions on network elements.

Tags must be easily detectable and accessible by the operator during maintenance activities throughout future network population and lifetime. These aspects must be considered both when a stand-alone tag is attached and when a network element is designed with an embedded tag.

#### 6.2.1.7 Environmental conditions and mechanical stress

It is recommended that an adequate operating temperature range is considered according to the different environmental conditions where RFID tags can be used. Tags should be tolerant of likely vibration sources such as powered equipment, road/rail traffic and civil works.

Application to movable network elements, such as cables, will impose flexing and other stresses to tags. There may be instances where tight curvatures is required of an inlay assembly when applied to a small diameter cable sheath, resulting in varying mechanical stress to the chip and its antenna connections.

#### 6.2.1.8 Data retention and MTBF

Data retention and MTBF of RFID tags should be designed taking the lifetime of the network elements into consideration.

#### 6.2.1.9 Installation

For stand-alone tags, it is recommended that cases are provided with adequate mechanical characteristics and material properties suitable for installation by means of external tools or adhesive components. It is highly desirable that fastenings are irremovable and tamperproof to ensure record continuity for the lifetime of the network element.

It is recommended to avoid, if it is possible, tag installation on or near metallic parts of network elements.

Tags should be permanently mounted on the network element or in such a manner that makes them difficult to remove.

### 6.2.2 QR code tag

#### 6.2.2.1 Notation

The specification of the QR code should be in accordance with [ISO/IEC 18004].

It is recommended that QR code be printed on a tag, sticker or element body.

#### 6.2.2.2 Durability

The QR code should be difficult to erase or remove from a tag, sticker or element body.

#### 6.2.2.3 Construction of tag

The tag construction and dimensions should not adversely affect maintenance work.

Tags should be permanently mounted on the network element or in such a manner that makes them difficult to remove.

#### 6.2.2.4 Environmental conditions

The QR code printed on the tag, sticker or element body should not change shape, be damaged or become blurred under the environmental conditions in which elements are installed.

# Appendix I

## Italian experience regarding RFID tag solution for telephony pole

(This appendix does not form an integral part of this Recommendation)

In Italy, RFID technology for maintenance support has been tested on the poles (almost all wooden) used in the wireline access network throughout the country.

The first step was to trace the in-field maintenance actions and to collect more information on these items in order to better understand the factors that affect pole lifetime. On one side, better knowledge of the poles network means avoiding random and massive monitoring actions, better spare parts management and network planning. On the other side, information maintenance can be certified because the tag is on the pole and stores information of the latest actions (date, operator code, etc.).

Typical periodical maintenance requires checking all poles inside a network area. More than 40'000 poles were checked in several networks area spread across the national territory.

The kind of item to be tagged and the operating environmental conditions required a special tag design.

The tag is ISO 14443 (proximity standard) compliant operating in the ISM band of 13.56 MHz. Short-range reading is not an issue because an operator can move his PDA very close to the tag (few centimetres). The non-volatile embedded memory is a 4 kbit EEPROM with a write protection feature. Memory size allows data storing according to information reported Table I.1.

**Table I.1 – Data structure for telephony pole**

| | |
|---|---|
| Site information | Geographical coordinates |
| | Network area |
| Element characteristic | Production year |
| | Material |
| | Length |
| | Capacity |
| Installation characteristic | Type |
| | Area |
| | Ground |
| | Presence of hanging strands |
| | Presence of any box |
| | Presence of grounding system |
| Check | State of conservation |
| | Result |
| | Maintenance actions |
| | Date |
| | Operator |

Since the memory is rewritable, the operator, after in-field maintenance, can update the data content.

The tag contains a unique 64-bit code that is used to identify the corresponding pole.

The operating temperature range (from –30°C to +85°C) and maximum number of read/write cycles ($10^6$) greatly satisfy application requirements.

Typical data retention for commercial tags is beyond 10 years and average wooden pole life is about 20 years. So data retention was tested using a climatic chamber simulating an ageing process of more than 20 years. At the end of the simulation memory content was read in all the tested tags.

Since tags must be affixed to the curved pole surface, commercial solutions are not suitable. The project was to design a case to contain the tag, typically delivered in plastic "film and reel" format. The bending radius depends on both the pole height and the position of the tag on the pole itself. The case is designed in order to fit the pole surface and to prevent film bending that could damage the copper elements in the tag. Double fixing points in the horizontal direction preserves tag position even in the presence of cracks in the wood. The solution is illustrated in Figure I.1.

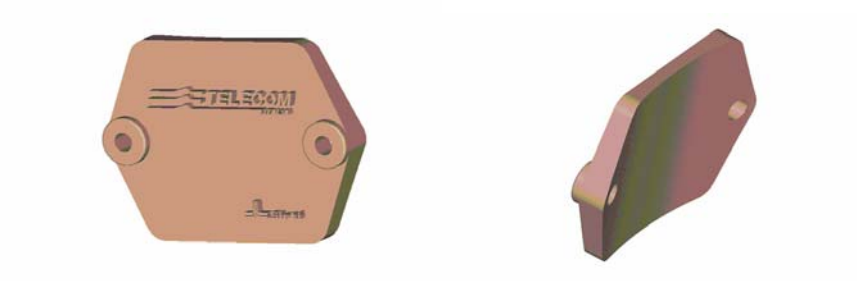



**Figure I.1 – Tag case design**

A polycarbonate with glass fibre case is used in order to guarantee secure fixing on wooden poles using screws or nails, even with tools such as electric screwdrivers or nail guns. On glass-fibre poles, tags can be glued using the large surface at the back of the tag. The climatic chamber is also used to test glue performance. Installation on wooden poles is illustrated in Figure I.2.

**Figure I.2 – Tag installation**

The described tag is intended for in-field installation on poles but it has been tested even to be embedded in poles. High-pressure chambers are typically used to inject preservative substances deep inside wooden poles in order to ensure they work for many years in difficult environmental conditions. Tags have been tested in this process with positive results, with no damage to the case, electronic circuits or data content.

# Appendix II

## Japanese experience: Administration system for optical fibres in a central office and access network

(This appendix does not form an integral part of this Recommendation)

### II.1 Introduction

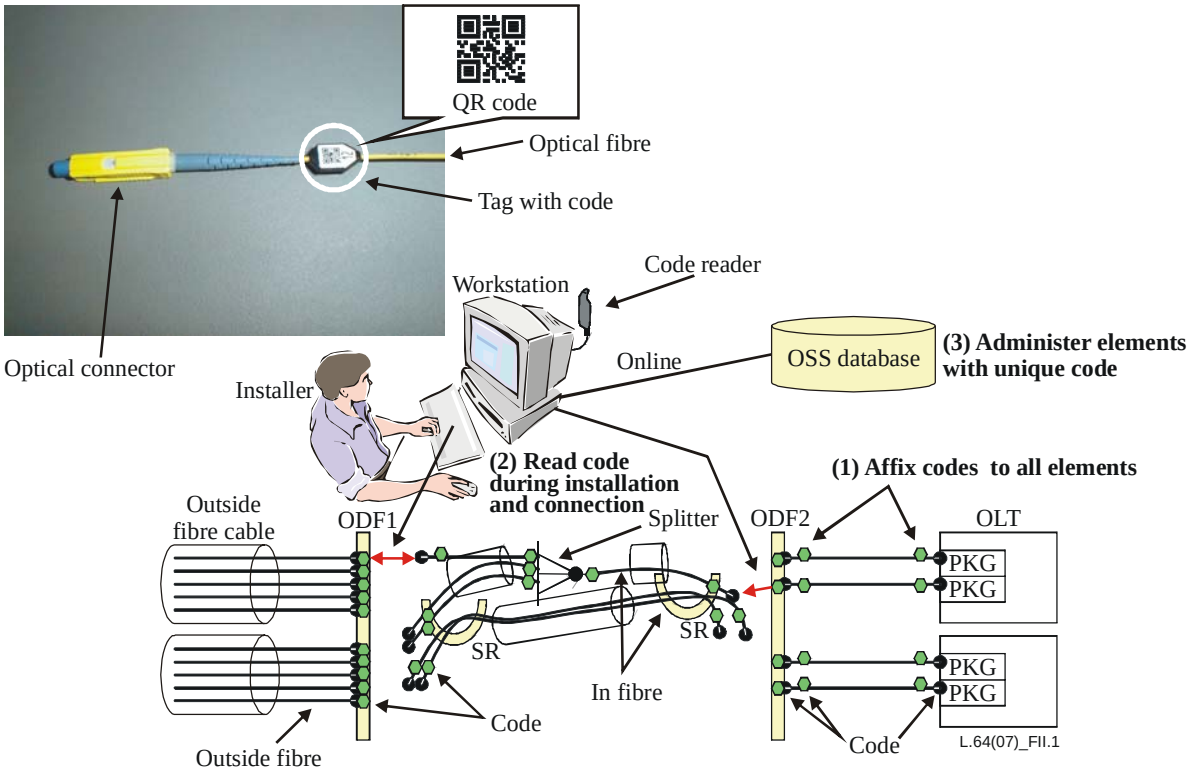
Many systems are being developed in the optical access network (OAN) field, including fibre-to-the-home and hybrid fibre-coax systems, and many network services are being provided that use these systems.

However, to provide these network systems more quickly and cost-effectively, we need an operations support system (OSS) that uses network elements effectively and increases the speed at which services are delivered to customers. An OSS is important for both customers and carriers because it has a great effect on both user convenience and carrier competition.

### II.2 Outline

This appendix describes a mature system. We introduce an administration system for optical fibres in a central office with the aim of managing a huge quantity of in-house equipment using a two-dimensional code (Figure II.1):

1) Every element that is an administrative target has a unique distinguishing code affixed to it. For example, a fibre has a code at each end and a splitter adapter has a code on each receptacle. These distinguishing codes are in a specific order and are mechanically affixed to elements when they are manufactured at the factory. This means that the installer is not required to affix a code to the elements.
2) The code is read electrically with a code reader and passed to the OSS when the intended target elements are installed and when they are connected or disconnected.
3) The OSS can then administer each target element.




ODF Optical Distribution Frame
PKG Package
SR Standby Rack
OLT Optical Line Termination
OSS Operations Support System

**Figure II.1 – Administration using distinguishing code**

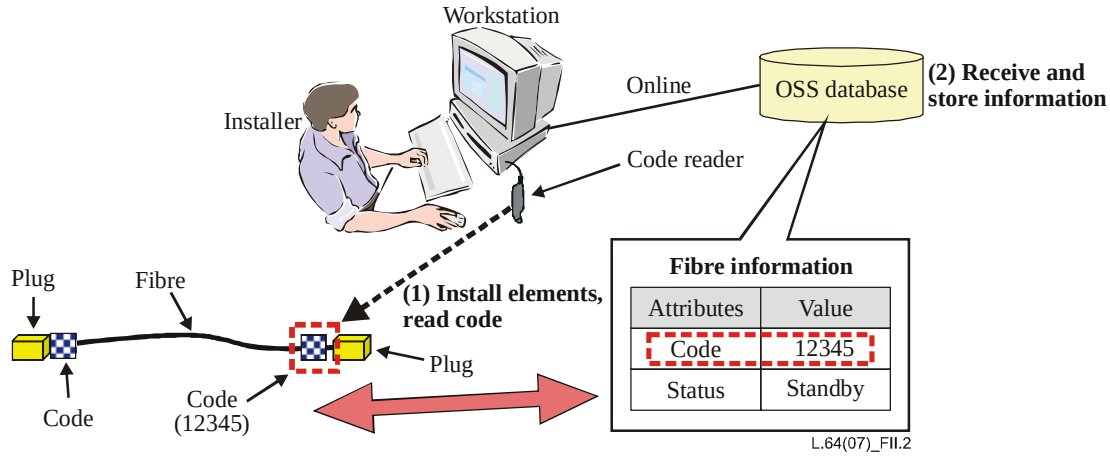
## II.3 Function

### II.3.1 Function of installation administration

1) When an installer installs an element, such as a fibre or splitter, he reads the affixed distinguishing code with a code reader (Figure II.2).

2) The OSS receives the element information and stores it in a database, using the code as a key attribute.

Consequently, this technique creates a precise link between the elements and the element information in the OSS database.




OSS Operations Support System

**Figure II.2 – Installation administration**

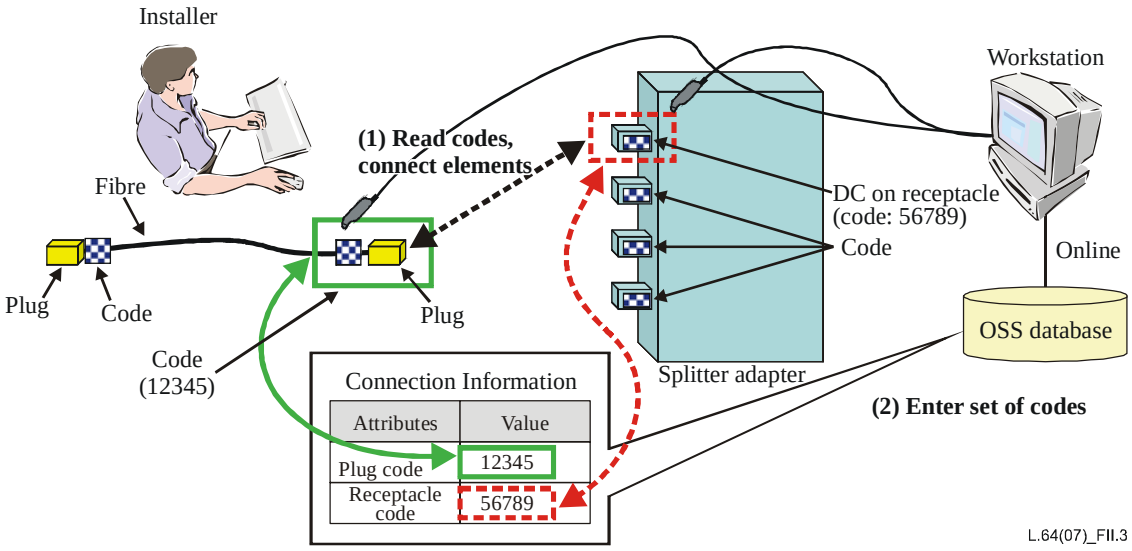
### II.3.2 Function of connection administration

1) When connecting a fibre plug to a splitter adapter receptacle, for example, the installer reads the distinguishing codes on both the plug and the receptacle (Figure II.3).

2) The OSS enters this set of codes in its database.

Precise information based on the relationship between the codes is thus stored in the database. This administration process would be executed by a service order to ensure that the appropriate elements are allocated effectively.

Moreover, with this process, the system can support the installer because it can detect the current state of the installation by reading the distinguishing codes in real time. Hence, the installer can be provided with pertinent information, such as the next task.




OSS Operations Support System

**Figure II.3 – Connection administration**

### II.3.3 Function of connection verification

1) In the example shown, an order to connect a fibre plug with a code of "12345" to a receptacle on a splitter whose code of "56789" had been previously entered in the OSS. The installer first reads the codes on the fibre plug and the receptacle (Figure II.4).

2) The OSS then verifies that the codes match those on the order.

3) If they match, the OSS advises the installer to make the connection. If they do not match, the OSS advises the installer to double-check that he has read the codes from the correct elements.

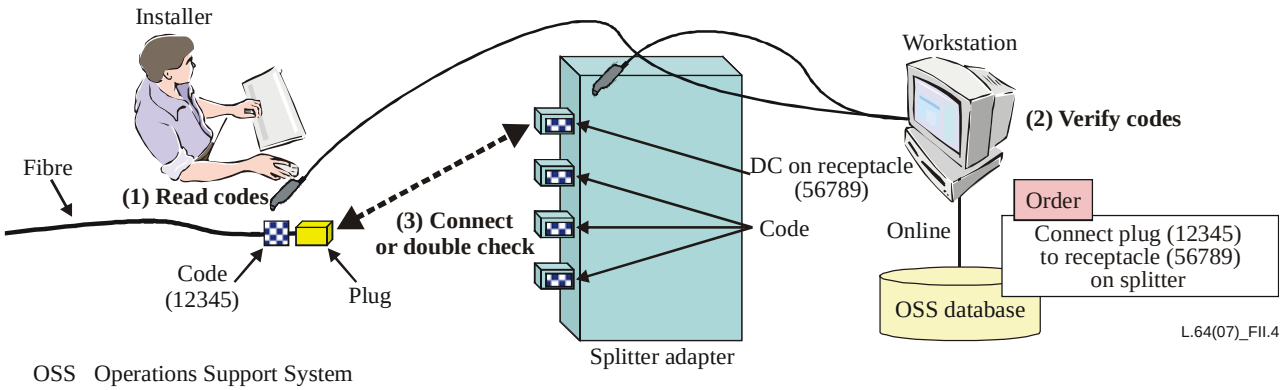



**Figure II.4 – Connection verification**

### II.3.4 Function of removal verification

1) In the example shown, an order to remove a fibre plug with a code of "12345" from a receptacle on a splitter with a code of "56789" had been previously entered into the OSS. Before removing the plug from the receptacle, the installer reads their codes (Figure II.5).

2) The system verifies that the removal target matches that on the order.

3) If there is no match, the system warns the installer not to remove the plug. If there is a match, the installer is advised to proceed with the removal.

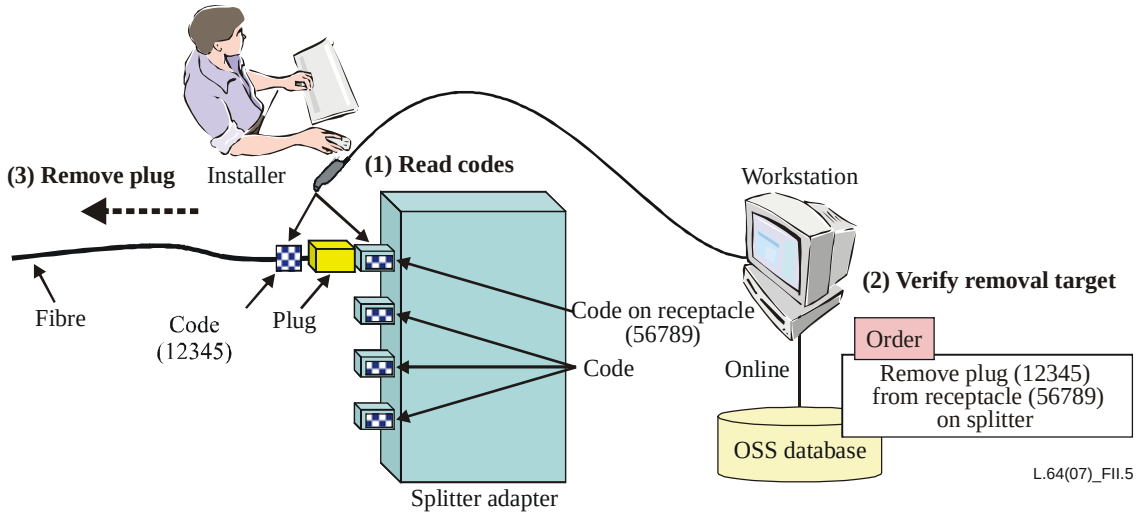



**Figure II.5 – Removal verification**

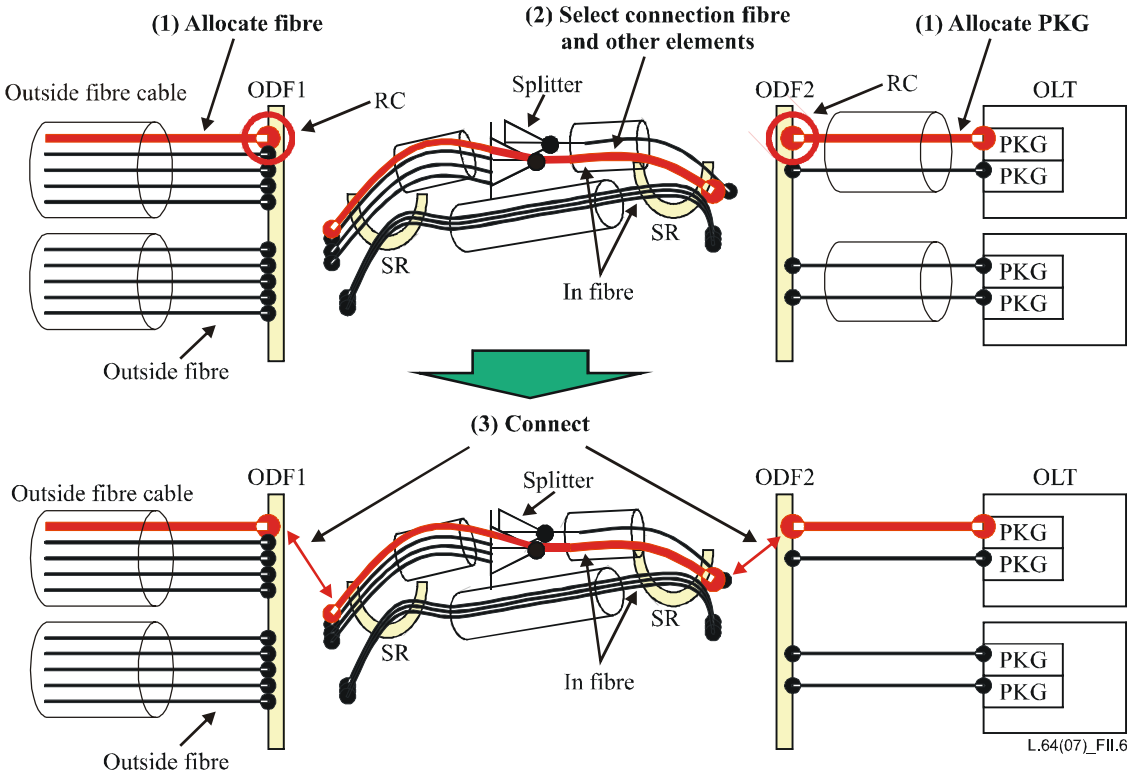
### II.3.5 Function of in fibre allocation

1) The first step is to allocate outside fibre and a device package (Figure II.6).

2) The outside fibre is allocated based on the customer's address, and the device package is allocated based on the type of service to be provided. Receptacles that correspond to the allocated elements are allocated on two connection racks. Next, connection fibres and other elements that make it possible to connect the receptacles on the two racks are selected based on the type of service.

3) Then, the connection fibres and elements are connected between the connection racks.

As mentioned in the introduction, the effective allocation of suitable elements is very important in terms of cost reduction. By "effective allocation" we mean the ordered and quick allocation of appropriate elements.




ODF Optical Distribution Frame
PKG Package
RC Receptacle
SR Standby Rack

**Figure II.6 – Fibre allocation**

### II.3.6 Function of maintenance

Share the DB and related information with the optical fibre maintenance support system.

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