

O-RAN.WG4.MP.0-v07.01

**O-RAN Alliance Working Group 4**

**Management Plane Specification**

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# Revision History

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# History

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Open-Fronthaul, lower-layer-split

# Foreword

This Technical Specification (TS) has been produced by O-RAN Alliance.

# Modal verbs terminology

In the present document "shall", "shall not", "should", "should not", "may", "need not", "will", "will not", "can" and "cannot" are to be interpreted as described in clause 3.2 of the O-RAN Drafting Rules (Verbal forms for the expression of provisions).  
본 문서에서 "해야한다", "하지 않아야 한다", "해야 한다", "하지 말아야 한다", "할 수 있다", "할 필요가 없다", "할 것이다", "하지 않을 것이다", "할 수 있다", "할 수 없다"는 O-RAN 초안 작성 규칙의 조항 3.2(조항 표현을 위한 구두 형태)에 설명된 대로 해석되어야 합니다.

"must" and "must not" are NOT allowed in O-RAN deliverables except when used in direct citation.  
"must" 및 "must not"은 직접 인용에 사용되는 경우를 제외하고 O-RAN 성과물에서 허용되지 않습니다.

# Executive summary

This Technical Specification defines the Management Plane for the O-RAN Open Fronthaul based on the selected lower-layer split point as defined within the Open Fronthaul Control Plane, User Plane and Synchronization Plane specification. This Technical Specification is used in combination with a set of associated YANG models to enable operation of an O-RAN alliance defined O-RU.  
이 기술 사양은 Open Fronthaul Control Plane, User Plane 및 Synchronization Plane 사양에 정의된 선택된 하위 계층 분할 지점을 기반으로 O-RAN Open Fronthaul의 관리 평면을 정의합니다. 이 기술 사양은 연관된 YANG 모델 세트와 함께 사용되어 O-RAN 얼라이언스 정의 O-RU의 작동을 가능하게 합니다.

# 1. Scope

This Technical Specification has been produced by the O-RAN.org.

The contents of the present document are subject to continuing work within O-RAN WG4 and may change following formal O-RAN approval. Should the O-RAN.org modify the contents of the present document, it will be re-released by O-RAN Alliance with an identifying change of release date and an increase in version number as follows:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Release x.y.z | | |
|  | where: | | |
|  |  | x | the first digit is incremented for all changes of substance, i.e., technical enhancements, corrections, updates, etc. (the initial approved document will have x=01). |
|  |  | y | the second digit is incremented when editorial only changes have been incorporated in the document. |
|  |  | z | the third digit included only in working versions of the document indicating incremental changes during the editing process. |

The present document specifies the management plane protocols used over the fronthaul interface linking the O-RU (O-RAN Radio Unit) with other management plane entities, that may include the O-DU (O-RAN Distributed Unit), the O-RAN defined **Service Management and Orchestration (SMO)** functionality as well as other generic Network Management Systems (NMS).  
본 문서에서는 O-RU(O-RAN 무선 장치)와 다른 관리 평면 엔티티를 연결하는 프런트홀 인터페이스에서 사용되는 관리 평면 프로토콜을 지정합니다. 여기에는 O-DU(O-RAN 분산 장치), O-RAN에서 정의한 서비스 관리 및 오케스트레이션(SMO) 기능은 물론 기타 일반 네트워크 관리 시스템(NMS)이 포함될 수 있습니다.

# 2. References

## 2.1 Normative References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

* References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
* For a specific reference, subsequent revisions do not apply.
* For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document in Release 15.

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# 3 Definitions of Terms and Abbreviations

## 3.1 Terms

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

**Antenna Line**: connection between O-RU and antenna

**C-Plane**: **Control Plane**: refers specifically to real-time control between O-DU and O-RU, and should not be confused with the UE’s control plane

**DL**: **DownLink**: data flow towards the radiating antenna (generally on the LLS interface)

**eAxC**: **extended Antenna-Carrier**: a data flow for a single antenna (or spatial stream) for a single carrier in a single sector.

**Event-Collector**: A REST server to which an O-RU supporting NON-PERSISTENT-NETCONF feature can send a JSON notification

**FHM mode**: Mode of Shared cell which is realized by FHM and several O-RUs in star topology.

**LLS**: Lower Layer Split: logical interface between O-DU and O-RU when using a lower layer (intra-PHY based) functional split.

**LLS-U**: Lower Layer Split User-plane: logical interface between O-DU and O-RU when using a lower layer functional split.

**LLS-C**: Lower Layer Split Control-plane: logical interface between O-DU and O-RU when using a lower layer functional split.

**LLS-S**: Lower Layer Split Synchronization-plane: logical interface between O-DU and O-RU when using a lower layer functional split.

**High-PHY**: those portions of the PHY processing on the O-DU side of the fronthaul interface, including FEC encode/decode, scrambling, and modulation/demodulation.

**Low-PHY**: those portions of the PHY processing on the O-RU side of the fronthaul interface, including FFT/iFFT, digital beamforming, and PRACH extraction and filtering.

**M-Plane**: Management Plane: refers to non-real-time management operations between the O-DU and the O-RU

**North-node**: the O-DU or a connected O-RU closer to the O-DU for the O-RU, e.g., the cascade O-RU#1 connected to O RU#2 is north-node for O-RU#2, when O-DU, O-RU#1 and O-RU#2 are in cascade chain topology. The O-DU in star topology connected to an FHM is north-node for the FHM.

**NMS**: A Network Management System dedicated to O-RU operations

**Port**: End of a transport link – in most cases this is an optical port

**Port Number**: A number which identifies a port (see Port). In case of SFP/SFP+ port, port number value is 0 to N-1 where N is number of ports in the device. Numbers 0 to N-1 are assigned to ports in order following order of labels on the device (labels for ports are not necessarily numbers starting from zero)

**O-DU**: O-RAN Distributed Unit: a logical node hosting PDCP/RLC/MAC/High-PHY layers based on a lower layer functional split.

**O-RU**: O-RAN Radio Unit: a logical node hosting Low-PHY layer and RF processing based on a lower layer functional split. This is similar to 3GPP’s “TRP” or “RRH” but more specific in including the Low-PHY layer (FFT/iFFT, PRACH extraction).

**O-RU Controller**: A network function that is permitted to control the configuration of an O-RU. Examples of O-RU controllers include, an O-DU, a classical NMS, an O-RAN Service Management and Orchestration function, or other network automation platforms.

**S-Plane**: Synchronization Plane: refers to traffic between the O-RU or O-DU to a synchronization controller which is generally an IEEE-1588 Grand Master (however, Grand Master functionality may be embedded in the O-DU).

**Shared cell**: The operation for the same cell by several O-RUs.

**Shared cell network**: the network for several cascade O-RUs in a chain topology or the network for one FHM and several O RUs in a star topology.

**South-node**: a connected O-RU far from O-DU for the O-RU, e.g., the cascade O-RU#2 connected to O-RU#1 is south-node for O-RU#1, when O-DU, O-RU#1 and O-RU#2 are in cascade chain topology. The O-RU in star topology connected to an FHM is south-node for the FHM.

**Spatial stream**: the data flow on the DL associated with precoded data (may be same as layers or different if there is expansion in the precoding), and on UL associated with the number of outputs from the digital beamforming (sometimes called “beams”).

**SSM**: Synchronization Status Message: part of ITU G.781 and G.8264 standards.

**TRX**: Refers to the specific processing chain in an O-RU associated with D/A or A/D converters. Due to digital beamforming the number of TRXs may exceed the number of spatial streams, and due to analogue beamforming, the number of TRXs may be lower than the number of antenna elements.

**U-Plane**: User Plane: refers to IQ sample data transferred between O-DU and O-RU

**UL**: Up-Link: data flow away from the radiating antenna (generally on the LLS interface)

**Virtual Connection**: a connection between O-RU and O-RU controller. This connection is established by means of autodetection procedure and is supervised by supervision procedure.

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

|  |  |  |
| --- | --- | --- |
|  | ALD | Antenna Line Device |
|  | AVP | Average Power |
|  | BCN | BTS Clock Number |
|  | CA | Certificate Authority |
|  | CA/RA | Certificate Authority/Registration Authority |
|  | CMP | Certificate Management Protocol |
|  | CRC | Cyclic Redundancy Check |
|  | CUS | Control/User/Synchronization |
|  | DHCP | Dynamic Host Configuration Protocol |
|  | DMTC | DRS Measurement Timing Configuration |
|  | DRS | Discovery Reference Signal |
|  | DSCP | Differentiated Services Code Point |
|  | FHM | Fronthaul Multiplexer |
|  | FTPES | File Transfer Protocol Explicit-mode Secure |
|  | HDLC | High-Level Data Link Control |
|  | lls-M | Lower Layer Split Management plane |
|  | LAA | Licensed Assisted Access |
|  | LBM | Loop-Back Message |
|  | LBR | Loop Back Reply |
|  | LBT | Listen Before Talk |
|  | ME | Maintenance Entity |
|  | MEP | Maintenance association End Point |
|  |  |  |
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|  |  |  |

# 4. General

## 4.1 Conventions

This management plane specification includes cross references to a set of associated YANG models. Text may reference particular YANG leafs, notifications and remote procedure calls (RPCs). In order to assist in readability, all cross references to YANG defined elements will keep the identical case format as defined in the corresponding YANG model, with the font-weight set to bold. This convention applies only to text and not to YANG elements embedded into figures.  
이 관리 플레인 사양에는 연관된 YANG 모델 집합에 대한 교차 참조가 포함됩니다. 텍스트는 특정 YANG 리프, 알림 및 원격 프로시저 호출(RPC)을 참조할 수 있습니다. 가독성을 돕기 위해 YANG 정의 요소에 대한 모든 교차 참조는 해당 YANG 모델에 정의된 것과 동일한 케이스 형식을 유지하고 글꼴 두께를 굵게 설정합니다. 이 규칙은 텍스트에만 적용되며 그림에 포함된 YANG 요소에는 적용되지 않습니다.

If there is any conflict between the YANG models and the accompanying text description in this specification, the definition of the YANG models shall take precedence.

## 4.2 Topics for Future Specification Versions

다음 주제는 사양의 향후 버전에서 고려되어야 합니다.

1. 다양한 유형의 빔포밍을 위한 빔 ID 필드 해석
2. 중복성 및 장애 조치 시나리오
3. IP 정의 흐름에 대한 공유 셀 지원
4. O-RAN Alliance O1 사양과 더 잘 일치하도록 개선

## 4.3 Revision and Compatibility Handling

The revision statement in the YANG models will be used to describe future revisions to the models that are backwards compatible, where backwards compatibility changes follow the rules defined in section 11 of RFC 7950 [4]. Backwards incompatible changes will be addressed by incrementing the number used as part of the model name and namespace, effectively creating a new YANG model. The format of the namespace used in all O-RAN YANG models is “urn:o-ran:”“:”, where the initial used in a newly defined YANG model is “1.0”. Where this document makes reference to models, irrespective of their backward compatibility, a generic of “x.y” is used to enable reference to all versions of the namespace for a particular .  
YANG 모델의 개정 설명은 이전 버전과 호환되는 모델에 대한 향후 개정을 설명하는 데 사용되며, 이전 버전과의 호환성 변경은 RFC 7950 [4]의 섹션 11에 정의된 규칙을 따릅니다. 이전 버전과 호환되지 않는 변경 사항은 모델 이름과 네임스페이스의 일부로 사용되는 숫자를 증가시켜 처리하여 효과적으로 새로운 YANG 모델을 만듭니다. 모든 O-RAN YANG 모델에서 사용되는 네임스페이스의 형식은 "urn:o-ran:"<모델 이름>":"<모델 번호>이며, 여기서 새로 정의된 YANG 모델에서 사용되는 초기 <모델 번호>는 "1.0"입니다. 이 문서에서 이전 버전과의 호환성과 관계없이 모델을 참조하는 경우, 특정 <모델 이름>에 대한 모든 버전의 네임스페이스를 참조할 수 있도록 "x.y"의 일반 <모델 번호>를 사용합니다.

The revision statement in all YANG models includes a reference statement used to cross-reference to the first version of this document where the corresponding description was introduced. For example, the reference in all revision statements for the initial O-RAN models include cross-reference to “ORAN-WG4.MP.0-v01.00”.  
모든 YANG 모델의 개정 설명서에는 해당 설명이 도입된 이 문서의 첫 번째 버전을 교차 참조하는 데 사용되는 참조 설명서가 포함되어 있습니다. 예를 들어, 초기 O-RAN 모델에 대한 모든 개정 설명서의 참조에는 "ORAN-WG4.MP.0-v01.00"에 대한 교차 참조가 포함되어 있습니다.

The revision statement of the YANG models also includes a description which is used to track the versioning of the YANG model. All revision statement descriptions will begin with “version ”“.”“.”, where , and are used to reflect the version of the YANG model, where

<a> corresponds to the first digit of the O-RAN WG4 management plane specification version where the corresponding description was first introduced, corresponding to in clause 1  
<b> is incremented when errors in the YANG model have been corrected  
<c> is incremented only in working versions of the YANG model indicating incremental changes during the editing process

NOTE : O-RU Controllers that receive YANG library information from the O-RU with a module revision that is a higher version than the module revision currently used by the O-RU Controller can assume that models with the same namespace have been updated to ensure backwards compatibility. The O-RU Controller can continue to use its current module version and any unknown schema nodes received from the O-RU, i.e., those introduced in later revisions, should be ignored by the O-RU Controller.

## 4.4 Namespace Compatibility Handling

If backwards incompatible changes have been made, the used in the YANG model namespace shall be incremented. Following such changes, an O-RU may include multiple backwards incompatible namespaces in its YANG library, for example “urn:o-ran:”“:1.0” and “urn:o-ran:”“:2.0”.  
이전 버전과 호환되지 않는 변경 사항이 있는 경우 YANG 모델 네임스페이스에서 사용되는 <모델 번호>가 증가합니다. 이러한 변경 사항에 따라 O-RU는 YANG 라이브러리에 여러 이전 버전과 호환되지 않는 네임스페이스를 포함할 수 있습니다. 예를 들어 "urn:o-ran:"<모델 이름> ":1.0" 및 "urn:o-ran:"<모델 이름> ":2.0"입니다.

The O-RAN Adopter License Agreement in Chapter ZZZ defines terms regarding the modification of O-RAN defined specifications. When such modifications are necessary, the preferred approach for realizing such is for the third-party licensee to publish their own augmentations to the O-RAN defined YANG models and procedures. An O-RU that supports such thirdparty modifications shall include such model augmentations in its YANG library. Consequently, an O-RU Controller should be prepared to ignore any unknown models, e.g., developed according to such a procedure.

# 5 High Level Description

## 5.1 Top level functional description, terminology, including hybrid, hierarchical

### 5.1.1 Architecture for O-RAN WG4 Fronthaul functional split

This O-RAN FH specification addresses the lower layer functional split as depicted in Figure 5.1.1.1. Refer to the O-RAN CUS plane specification [2] for more details on the split architecture. The Lower-Layer Split M-plane (LLS-M) facilitates the initialization, configuration and management of the O-RU to support the stated functional split.  
이 O-RAN FH 사양은 그림 5.1.1.1에 나와 있는 것과 같이 하위 계층 기능 분할을 다룹니다. 분할 아키텍처에 대한 자세한 내용은 O-RAN CUS 평면 사양[2]을 참조하십시오. 하위 계층 분할 M 평면(LLS-M)은 명시된 기능 분할을 지원하기 위해 O-RU의 초기화, 구성 및 관리를 용이하게 합니다.

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### 5.1.2 M-Plane architecture model

A NETCONF/YANG based M-Plane is used for supporting the management features including “start up” installation, software management, configuration management, performance management, fault management and file management towards the O-RU. The M-Plane supports two architectural models:

1. **Hierarchical model**. As shown on the left side Figure 5.1.2.1, the O-RU is managed entirely by one or more O-DU(s) using a NETCONF based M-Plane interface. When the O-RU is managed by multiple O-DUs, it is typically for enabling O-DU and/or transport connectivity redundancy capabilities. Refer to clause 6 for more details.  
   왼쪽 그림 5.1.2.1에 표시된 대로 O-RU는 NETCONF 기반 M-Plane 인터페이스를 사용하는 하나 이상의 O-DU에 의해 완전히 관리됩니다. O-RU가 여러 O-DU에 의해 관리되는 경우 일반적으로 O-DU 및/또는 전송 연결 중복 기능을 활성화하기 위한 것입니다. 자세한 내용은 조항 6을 참조하십시오.
2. **Hybrid model**. As shown on the right side of Figure 5.1.2.1, the hybrid architecture enables one or more direct logical interface(s) between management system(s) and O-RU in addition to a logical interface between O-DU and the O-RU. It should be noted that the NETCONF clients connecting to the O-RU may be of different classes (e.g., O-DU and SMO). For example, functions like O-RU software management, performance management, configuration management and fault management can be managed directly by the management system(s).  
   그림 5.1.2.1의 오른쪽에 표시된 것처럼 하이브리드 아키텍처는 O-DU와 O-RU 간의 논리적 인터페이스 외에도 관리 시스템과 O-RU 간에 하나 이상의 직접적인 논리적 인터페이스를 가능하게 합니다. O-RU에 연결하는 NETCONF 클라이언트는 서로 다른 클래스(예: O-DU 및 SMO)일 수 있습니다. 예를 들어, O-RU 소프트웨어 관리, 성능 관리, 구성 관리 및 오류 관리와 같은 기능은 관리 시스템에서 직접 관리할 수 있습니다.

In the hybrid model, the O-RU has end to end IP layer connectivity with the SMO. From a physical network point of view, this connectivity could be via the O-DU, where the O-DU is acting as an IP/Ethernet packet forwarder, forwards the packets between O-RU and the SMO. Direct logical communication between an O-RU and SMO can be enabled via O-RUs being assigned routable IPs or local private IPs resolved by a NAT function in the network (or implemented at the O-DU). Refer to clause 6 for details how O-RU acquires the IP address of O-DU and SMO for the M-plane communication.  
하이브리드 모델에서 O-RU는 SMO와 엔드투엔드 IP 계층 연결을 갖습니다. 물리적 네트워크 관점에서 이 연결은 O-DU를 통해 이루어질 수 있으며, 여기서 O-DU는 IP/Ethernet 패킷 포워더 역할을 하며 O-RU와 SMO 간에 패킷을 전달합니다. O-RU와 SMO 간의 직접적인 논리적 통신은 O-RU에 네트워크의 NAT 기능(또는 O-DU에서 구현)으로 해결되는 라우팅 가능 IP 또는 로컬 개인 IP가 할당되어 활성화될 수 있습니다. O-RU가 M-플레인 통신을 위해 O-DU와 SMO의 IP 주소를 획득하는 방법에 대한 자세한 내용은 절 6을 참조하십시오.

As described in clause 6, there is no explicit signalling to indicate that an O-RU is operating in a hierarchical or hybrid configuration. All NETCONF servers supporting this M-Plane specification shall support multiple NETCONF sessions, and hence all compliant O-RUs shall be able to support both hierarchical and hybrid deployment.  
6절에 설명된 대로, O-RU가 계층적 또는 하이브리드 구성에서 작동하고 있음을 나타내는 명시적 신호는 없습니다. 이 M-Plane 사양을 지원하는 모든 NETCONF 서버는 여러 NETCONF 세션을 지원해야 하며, 따라서 모든 호환 O-RU는 계층적 및 하이브리드 배포를 모두 지원할 수 있어야 합니다.

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NETCONF/YANG is used as the network element management protocol [3] and data modelling language [4]. Use of such a standardized framework and common modelling language simplifies integration between O-DU and O-RU as well as operator network integration (in terms of running service) in case of elements sharing a common set of capabilities. The framework supports integration of products with differing capabilities enabled by well-defined published data models. NETCONF also natively supports a hybrid architecture which enables multiple clients to subscribe and receive information originating at the NETCONF server in the O-RU.

### 5.1.3 Transport Network