Standardization

RAN Fronthaul Open

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# Overview of O-RAN Fronthaul Specifications

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Standard specifications for fronthaul interfaces with a view to the next-generation radio access network were released by the xRAN Forum in April 2018. Then, with the integration of the xRAN Forum into the O-RAN Alliance in March 2019, these specifications continued on as O-RAN fronthaul specifications. This article describes the O-RAN fronthaul specifications that are expected to be the first standard to enable interoperability between different vendors.

## 1. Introduction

As architecture already adopted by operators in many countries for their Radio Access Network (RAN)*1, Centralized RAN (C-RAN)*2 connects a baseband processing section in centralized base station equipment to multiple units of radio equipment via fronthaul*3 (**Figure 1**). In C-RAN, a centralized control section provides performance benefits through inter-cell and inter-frequency coordination while the centralized installation of equipment provides cost benefits through resource pooling and reduced installation space [1].

On the other hand, the Common Public Radio Interface (CPRI)*4 specifications that have come to be used in conventional C-RAN do not sufficiently



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*1 RAN: The network consisting of radio base stations and radio-circuit control equipment situated between the core network and mobile terminals.

*2 C-RAN: A radio access network having a configuration that consolidates the baseband processing sections of base station equipment and controls the radio sections of that equipment through optical fiber connections.

*3 Fronthaul: Circuit between the baseband processing section in base station equipment and radio equipment using optical fiber.

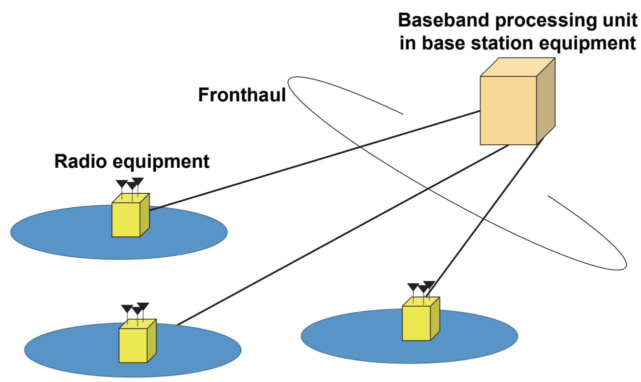


Figure 1　C-RAN overview

prescribe specifications for fronthaul interfaces, and as a result, there are now many regions having original specifications prescribed by different vendors. This state of affairs has made it difficult to achieve interoperability between baseband processing equipment and radio equipment from different vendors (hereinafter referred to as "multivendor RAN"). It has also been pointed out from many quarters that wider frequency bandwidths in the 5G era and higher antenna counts due to Massive Multiple Input Multiple Output (Massive MIMO)*5 schemes are increasing the required fronthaul transmission bandwidth and making it excessively large [2].

The Open RAN (O-RAN) fronthaul specifications were formulated against this background and are expected to help make multivendor RAN a reality in the 5G era.

Furthermore, in the face of this bandwidth problem, O-RAN fronthaul specifications include a new provision for functional splitting called Split Option 7-2x that places in radio equipment some Layer 1*6 functions traditionally located in the baseband processing section. They also prescribe Control, User and Synchronization Plane (C/U/S-Plane)*7 specifications that, while conforming to the eCPRI*8 framework, prescribe detailed signal formats and equipment operation required for multivendor RAN not prescribed in eCPRI specifications, and Management Plane (M-Plane)*9 specifications as well. These O-RAN fronthaul specifications support both New Radio (NR) and LTE as Radio Access Technology (RAT)*10. In this article, we first introduce Split Option 7-2x and then describe C/U/S-Plane and M-Plane specifications.

## 2. Split Option 7-2x

Split Option 7-2x is a specification for functional splitting between O-RAN Distributed Unit (O-DU) and O-RAN Radio Unit (O-RU) adopted by O-RAN

*4　CPRI: Internal interface specification for radio base stations. CPRI is also the industry association regulating the specification.

*5　Massive MIMO: Large-scale MIMO using a very large number of antenna elements. Since antenna elements can be miniaturized in the case of high frequency bands, Massive MIMO is expected to be useful in 5G.

*6　Layer 1: The first layer (physical layer) in the OSI reference model.

*7　C/U/S-Plane: The C-Plane and U-Plane are protocols for transferring control signals and user data, respectively. The S-Plane is protocol for achieving synchronization between multiple units of equipment.

*8　eCPRI: Internal interface specification for radio base stations prescribed by CPRI, an industry association.

*9　M-Plane: The management plane handling maintenance and monitoring signals.

*10　RAT: A radio access technology such as NR, LTE, 3G, GSM, and Wi-Fi.

fronthaul specifications. An overview of Split Option 7-2x is shown in **Figure 2**.

In the downlink (DL) process flow, the user bit sequence received from the Medium Access Control (MAC) layer*11 undergoes encoding and scrambling*12, modulation and layer mapping, and precoding*13 and resource element mapping*14 resulting in an IQ sampling sequence*15 of an Orthogonal Frequency Division Multiplexing (OFDM)*16 signal in the frequency domain*17. This sequence is then subjected to Inverse Fast Fourier Transform (IFFT)*18 processing, converted to an OFDM signal in the time domain*19, and finally converted to an analog signal. In this flow, Beam Forming (BF)*20 is performed before IFFT processing in the case of digital BF and after analog-signal conversion in the case of analog BF.

In the DL, Split Option 7-2x implements functions up to resource element mapping in the O-DU and supports both an O-RU that implements digital BF and later functions (Category A O-RU) and an O-RU that implements the above in combination with precoding (Category B O-RU). Here, Category A O-RU, which is easy to deploy, is expected to be the O-RU implementation of choice in 5G initial deployment. On the fronthaul an IQ sampling sequence of the OFDM signal in the frequency domain for each MIMO spatial stream (Category A O-RU) or each MIMO layer (Category B O-RU) will be transmitted. There is no need to transmit

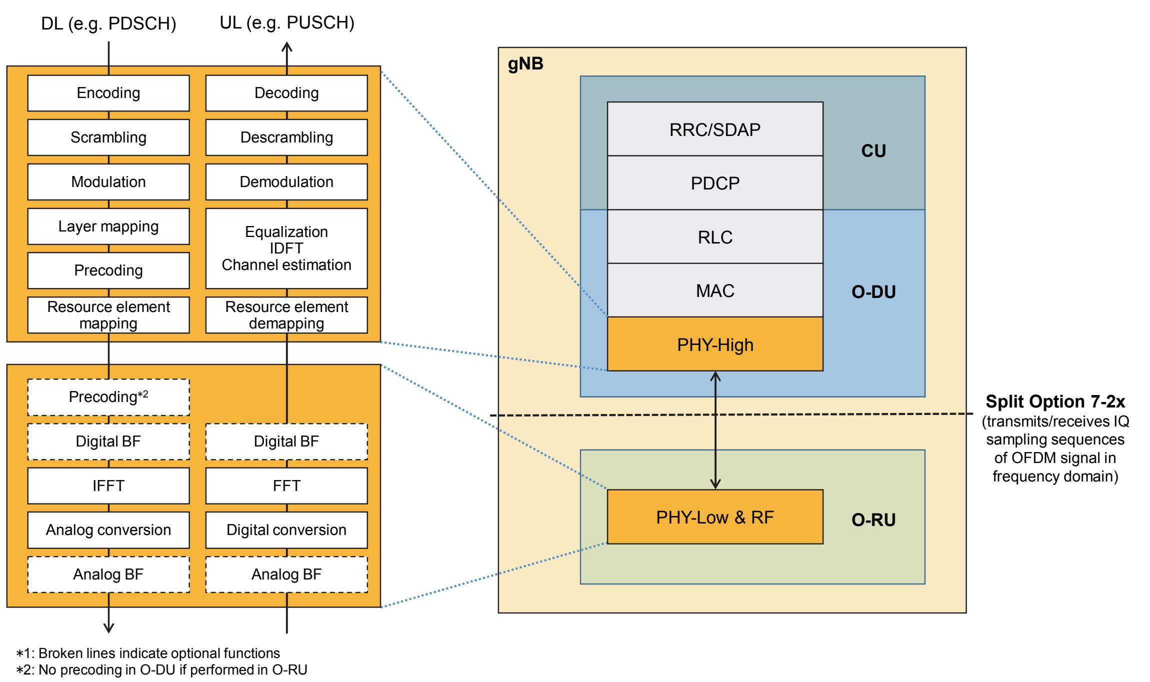


Figure 2 Split Option 7-2x adopted in O-RAN fronthaul specifications

*11 MAC layer: One of the sublayers of Layer 2 providing protocols for allocating radio resources, mapping data, and controlling retransmission.

*12 Scrambling: Masking of a data block to be transmitted using a specific bit sequence determined by the user or cell identifier.

*13 Precoding: A process for improving the quality of signal reception by multiplying the signal before transmission with weights according to the condition of the radio propagation channel.

*14 Resource element mapping: The mapping of an IQ sampling sequence to time/frequency resources in LTE, LTE-Advanced, and NR.

*15 IQ sampling sequence: A sampling sequence consisting of in-phase and quadrature components of a complex digital signal.

*16 OFDM: A digital modulation method where information is divided into multiple orthogonal carrier waves and sent in parallel making for high spectral efficiency in transmission.

*17 Frequency domain: In signal analysis, this domain is used to show the frequency makeup of a signal's components. A frequency-domain signal can be converted to a time-domain signal by an inverse Fourier transform.

on the fronthaul an IQ sampling sequence for a frequency resource transmitting no signals on the DL wireless interface.

Next, in the UpLink (UL) process flow, the OFDM signal in the time domain received at the O-RU and converted to a digital signal is subjected to FFT processing resulting in an IQ sampling sequence of the OFDM signal in the frequency domain. Then, after resource element demapping*21, the process flow continues with equalizing processing, Inverse Discrete Fourier Transform (IDFT)*22 processing, and channel estimation, and after demodulation, descrambling*23, and decoding, the process sends a user bit sequence*24 to the MAC layer. In this flow, BF is performed after FFT processing in the case of digital BF and before digital-signal conversion in the case of analog BF.

In the UL, Split Option 7-2x implements resource element mapping and higher functions in the O-DU and digital BF and lower functions in the O-RU. The fronthaul transmits an IQ sampling sequence of the OFDM signal in the frequency domain for each MIMO spatial stream. There is no need to transmit on the fronthaul an IQ sampling sequence for a frequency resource transmitting no signals on the UL wireless interface.

As shown in **Figure 3**, tradeoffs exist in the way that functional splitting is performed between the

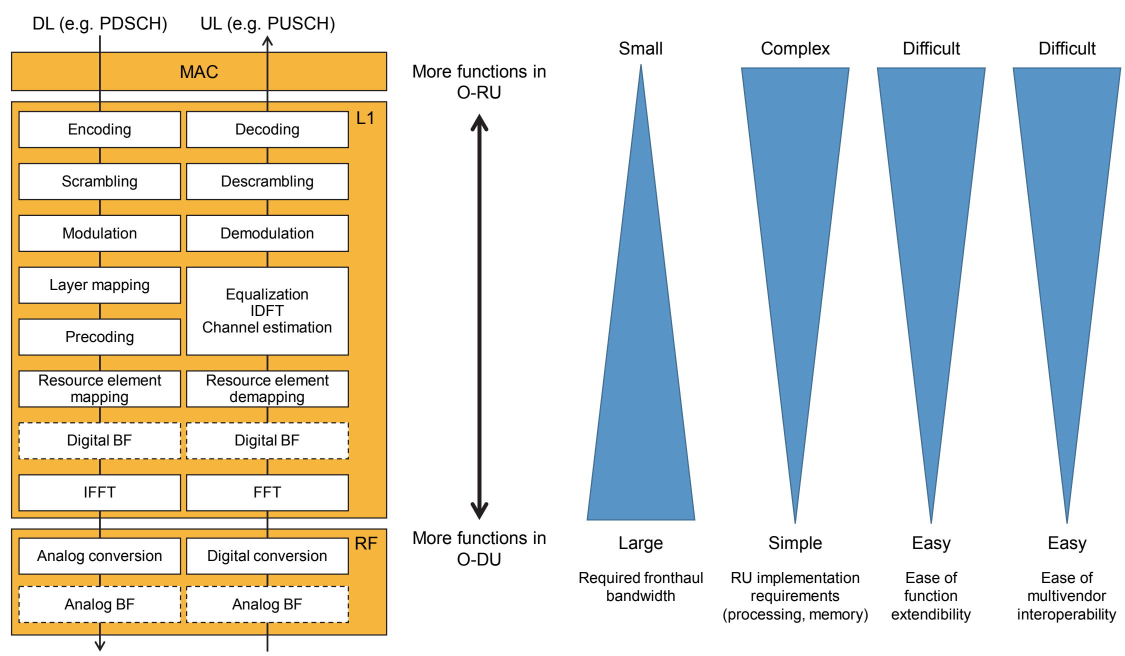


**Figure 3 Tradeoffs in O-DU and O-RU functional splitting**

*18 IFFT: A method for efficiently computing the time signal series corresponding to input frequency components (discrete data).

*19 Time domain: In signal analysis, this domain is used to show the temporal makeup of a signal's components. A time-domain signal can be converted to a frequency-domain signal by a Fourier transform.

*20 BF: A technique for increasing or decreasing the gain of antennas in a specific direction by controlling the amplitude and phase of multiple antennas to form a directional pattern of the antennas.

*21 Resource element demapping: A process for extracting an IQ signal sequence from an IQ signal mapped to time/frequency resources in LTE, LTE-Advanced, and NR.

*22 IDFT: An inverse discrete Fourier transform used to convert discrete data in the frequency domain to discrete data in the time domain.

*23 Descrambling: Unmasking of a received data block using a specific bit sequence determined by the user or cell identifier.

O-DU and O-RU. In general, the required fronthaul bandwidth becomes smaller as more functions become entrusted to the O-RU. For example, compared to CPRI in which the O-RU handles only the RF function section, placing IFFT/FFT processing in the O-RU can prevent an increase in the fronthaul required bandwidth caused by oversampling applied to the OFDM signal in the time domain. Similarly, placing DL precoding in the O-RU can prevent an increase in the required fronthaul bandwidth that occurs when the number of MIMO spatial streams is greater than the number of MIMO layers.

Furthermore, when the O-RU handles all Layer 1 functions, the required fronthaul bandwidth is essentially comparable to the baseband*25 bit rate. On the other hand, in that case, the amount of processing and memory required of dispersed O-RUs increases. Additionally, when making function modifications and extensions, it is often the case that not just the O-DU but the O-RU too must be upgraded.

Moreover, when performing resource element mapping/demapping on the O-DU side, data will be transmitted after user multiplexing thereby simplifying control signals on the fronthaul and making it easier to achieve multivendor RAN. Split Option 7-2x was adopted taking these tradeoffs into consideration.

## 3. Overview of Fronthaul Interfaces

### 3.1 Protocol Stacks

The protocol stack*26 of each plane in O-RAN fronthaul specifications are shown in **Figure 4**.

In the C/U-Plane, the O-RAN fronthaul specifications support a protocol stack that transmits signals used by eCPRI or Radio over Ethernet (RoE)*27 directly over Ethernet and an optional protocol stack that transmits the signals over User Datagram

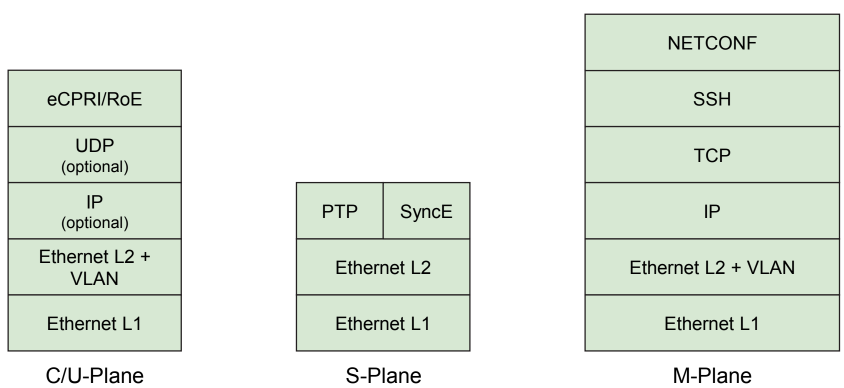


**Figure 4 Protocol stack of each plane**

*24 User bit sequence: The baseband bit sequence of user data.
*25 Baseband: The units or functional blocks that perform digital signal processing.
*26 Protocol stack: Protocol hierarchy.
*27 RoE: Internal interface specifications of a radio base station prescribed by IEEE.

Protocol (UDP)*28/IP.

In the S-Plane, meanwhile, the O-RAN fronthaul specifications support a protocol stack that transmits signals used in Precision Time Protocol (PTP)*29 and SyncE*30 over Ethernet.

Finally, in the M-Plane, the O-RAN fronthaul specifications support a protocol stack that transmits signals used in NETwork CONFiguration protocol (NETCONF) over Ethernet/IP/Transmission Control Protocol (TCP)*31/Secure SHell (SSH)*32.

NETCONF, which was formulated as RFC6241 in the Internet Engineering Task Force (IETF)*33, is a general-purpose protocol for managing network devices. The O-RAN fronthaul specifications are mainly concerned with the data model portion of NETCONF that is targeted by operations and treated as a matter of implementation.

## 3.2 C/U-Plane

1) U-Plane

The frame format for a U-Plane message is shown in **Figure 5**. The eCPRI header contains information such as message type (ecpriMessage), eCPRI payload*34 size (ecpriPayload), message source and destination identifiers (ecpriPcid), and message sequence number (ecpriSeqid). The O-RAN fronthaul specifications prescribe an extended Antenna-Carrier (eAxC) as message source and destination identifiers.

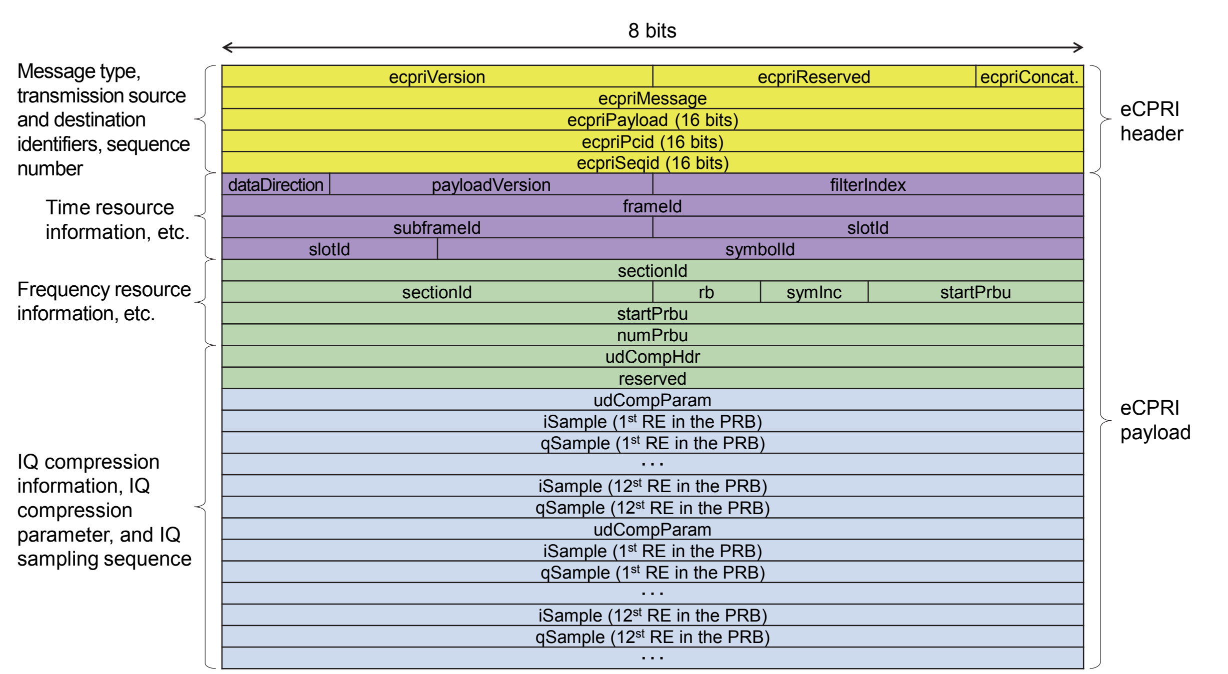


**Figure 5 U-Plane message frame format**

*28 UDP: A protocol on the transport layer featuring light processing by virtue of performing no delivery confirmation, congestion control, etc. It is used in communications for which a loss of data during transmission does not present a major problem.

*29 PTP: A protocol for achieving high-accuracy time synchronization among equipment connected to a network.

*30 SyncE: A system for transmitting clock signals on the Ethernet.

*31 TCP: A standard Internet upper-layer protocol above IP. It complements IP by providing functions for confirming the other party in the connection and data arrival, performing flow control, and detecting data duplication or loss to achieve highly reliable communication.

*32 SSH: A protocol for achieving secure remote login and providing network services.

*33 IETF: A standardization organization that develops and promotes standards for Internet technology. The technology specifications formulated here are published as Request For Comment documents (RFCs).

As shown in **Figure 6**, this eAxC consists of an O-DU port IDentifier (DU_Port_ID), Band Sector IDentifier (BandSector_ID), Component Carrier (CC)*35 IDentifier (CC_ID), and O-RU port IDentifier (RU_Port_ID). A specific MIMO spatial stream or MIMO layer is identified on the basis of RU_Port_ID.

The eCPRI payload of the U-Plane message can be used to transmit an IQ sample (iSample/qSample) sequence of the OFDM signal in the frequency domain applying IQ compression and IQ compression information (udCompHdr). This information is transmitted together with time/frequency resource information that should be applied to the transmission and reception of the IQ sample sequence on the radio interface. Details of this eCPRI payload information are provided in O-RAN fronthaul specifications but not in eCPRI. Here, time resource information consists of identification information for radio frame*36, subframe*37, slot*38, and OFDM symbol*39 while frequency resource information consists of the Physical Resource Block (PRB)*40 start position and number of PRBs (startPRBu, numPRBu). The IQ compression information consists of the applied compression scheme and the number of bits in the IQ sample after compression. Specifically, IQ compression is performed using a common IQ compression parameter (udCompParam) for each PRB (12 IQ samples). For example, when applying block floating point*41 as the compression scheme, the IQ compression parameter and IQ sample sequence represent an exponent and mantissa, respectively, in floating point form.

In addition, the frame format of the U-Plane message is used in common in both directions, that is, for transmission from the O-DU to O-RU and transmission from the O-RU to O-DU.

2) C-Plane

The frame format for a C-Plane message is shown in **Figure 7**. The eCPRI header in a C-Plane message is the same as that of the U-Plane message. Here, the C-Plane message source and destination identifiers have become ecpriRtcid in contrast to ecpriPcid of the U-Plane message. In O-RAN fronthaul specifications, however, these identifiers are prescribed as an extended Antenna-Carrier (eAxC) the same as in the U-Plane message.

The eCPRI payload of the C-Plane message passed from the O-DU to O-RU consists of information specifying BF weights to be applied when transmitting and receiving IQ sample sequences included in the U-Plane message on the radio interface. It also consists of time resource information (the same

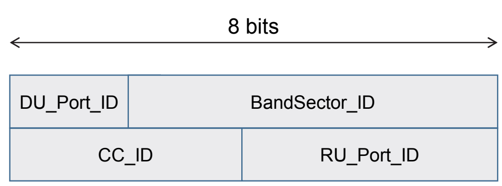


**Figure 6　Example of eAxC**

*34 **Payload:** The part of the transmitted data that needs to be sent, excluding headers and other overhead.

*35 **CC:** Term referring to one of several carriers bundled together to achieve CA (see *44).

*36 **Radio frame:** The smallest unit used for signal processing (encoding, decoding). A single radio frame is composed of multiple slots (or subframes) along the time axis, and each slot is composed of multiple symbols along the time axis.

*37 **Subframe:** A unit of radio resources in the time domain, consisting of multiple slots.

*38 **Slot:** A unit for scheduling data consisting of multiple OFDM symbols.

*39 **OFDM symbol:** A unit of transmission data consisting of multiple subcarriers. A Cyclic Prefix (CP) is inserted at the front of each symbol.

*40 **PRB:** A unit for allocating radio resources consisting of one subframe and 12 subcarriers.

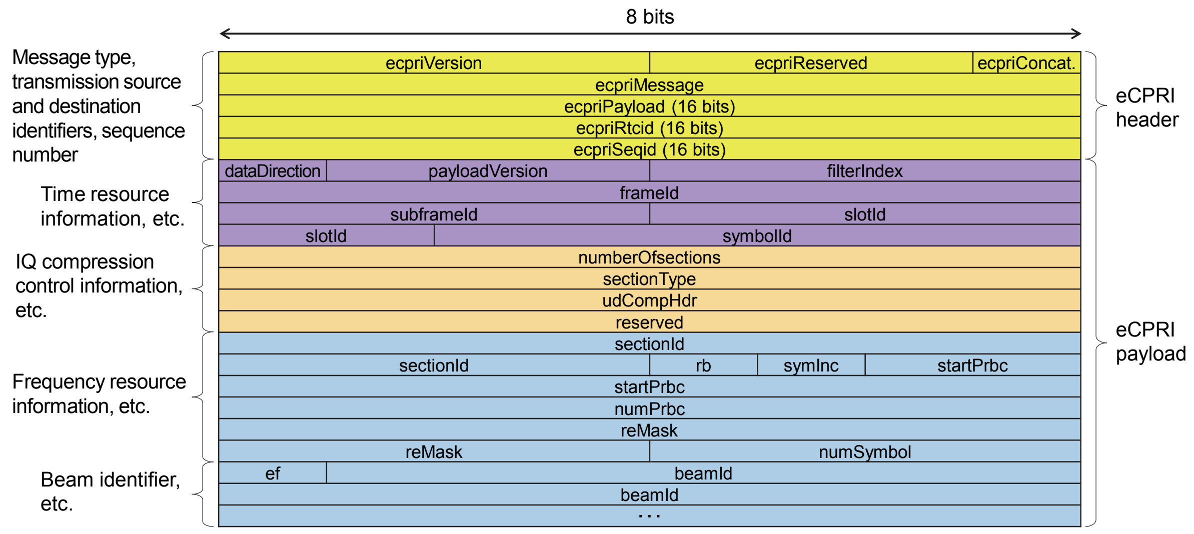


**Figure 7　C-Plane message frame format (beam identifier)**

as the U-Plane message) and frequency resource information (startPRBc, numPRBc) to which the above BF weights are to be applied. The O-RU uses this information to generate a beam for transmitting and receiving signals on the radio interface. A number of options have been prescribed as information for specifying BF weights, but in O-RAN fronthaul specifications, support for an interface using a beam identifier (beamId) as shown in Fig. 7 is mandated. In addition, this option using a beam identifier can be applied to digital BF, analog BF, or a combination of the two (hybrid BF).

3) Delay Management

Split Option 7-2x, which inserts a functional split between O-DU and O-RU within the physical layer of the radio interface, includes delay management given the need to transmit C/U-Plane messages on the fronthaul in accordance with transmit/receive timing of the radio interface and retransmission timing of the Hybrid Automatic Repeat reQuest (HARQ)*42 technique. This form of delay management adopts the concept of a receive window and transmit window based on the eCPRI framework.

Delay management for transmission from the O-DU to O-RU is shown in **Figure 8**. On receiving the IQ sample sequence of the OFDM signal in the frequency domain from the fronthaul, the O-RU must complete certain processing (IFFT, analog conversion, BF, etc.) in time for transmitting the signal on the radio interface given specific time resources (radio frame, subframe, slot, OFDM symbol). For this reason, the position of the O-RU receive window is set before transmission timing on the radio interface at an offset corresponding to this O-RU processing delay. The O-DU, meanwhile, must transmit a C/U-Plane message to the fronthaul so

*41 **Block floating point:** A method used when expressing data in floating point form that calculates each data block with a common exponent instead of calculating each data item with a separate exponent.

*42 **HARQ:** A technique that compensates for errors in received signals through a combination of error-correcting codes and retransmission.

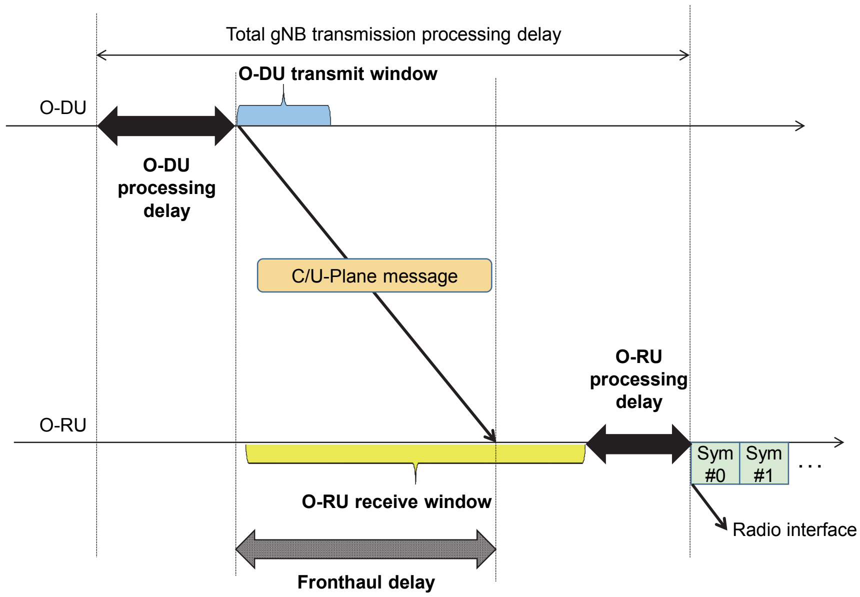


Figure 8 Delay management (transmission from O-DU to O-RU)

that it is delivered within the O-RU receive window. Accordingly, the position of the O-DU transmit window is set before transmission timing to the radio interface at an offset corresponding to O-RU processing delay and fronthaul delay. Here, fronthaul delay includes variable elements such as fronthaul distance and switch processing delay. The size of the O-RU receive window is set to a length that can cover this fluctuation in fronthaul delay and size of the O-DU transmit window. The size of the O-DU transmit window is set taking into account the processing time required for the O-DU to transmit the C/U-Plane message to the fronthaul.

Delay management using the same type of windows is also applied for transmission in the direction from O-RU to O-DU. Additionally, though omitted in Fig. 8, the fronthaul specifications define separate windows for the C-Plane and U-Plane.

## 3.3 S-Plane

In a C-RAN configuration, highly accurate synchronization between O-DU and O-RUs is required to achieve linking control that assumes inter-O-RU synchronization for Time Division Duplex (TDD)*43, Carrier Aggregation (CA)*44 using multiple O-RUs, MIMO, and other processes. As an S-Plane, O-RAN fronthaul specifications support protocols such as PTP and SyncE to achieve high-accuracy synchronization on the O-RU side by synchronizing with the clock on the high-performance O-DU side.

*43 TDD: A bidirectional transmit/receive system. It achieves bidirectional communication by allocating different time slots to uplink and downlink transmissions that use the same frequency band.

*44 CA: A technology that expands bandwidth and achieves high-speed transmission by performing simultaneous transmission and reception on multiple component carriers.

## 3.4 M-Plane

The M-Plane provides a variety of O-RU management functions to set parameters on the O-RU side as required by the C/U-Plane and S-Plane described above, to manage O-RU software (SW), perform fault management, etc. In this regard, O-RAN fronthaul specifications prescribe various parameters as data models to achieve the above. This eliminates dependence on each O-RU vendor's implementation and makes multivendor RAN possible.

The functions supported by the M-Plane are listed in **Table 1**.

1) M-Plane Architecture

In the M-Plane, the O-DU and Network Management System (NMS)*45 are specified as network devices managing O-RUs. In NETCONF, moreover, network devices managing O-RUs correspond to NETCONF clients while O-RUs targeted for management correspond to NETCONF servers.

The following two models are supported as M-Plane architecture (**Figure 9**).

(a) Hierarchical model: In this configuration, an O-RU is managed by one or more O-DUs. These O-DUs terminate the monitoring/control of a subordinate O-RU, which makes it unnecessary for NMS to handle the monitoring/control of all O-RUs and helps reduce the NMS processing load. Furthermore, in the event that the existing NMS does not yet support NETCONF, this model has the advantage of enabling network construction without affecting the existing system since O-DU supports NETCONF in this M-Plane.

(b) Hybrid model: In this configuration, an O-RU is managed by one or more NMSs in addition to O-DUs. An advantage of this model is that NMSs can monitor/control other network devices in addition to O-RUs enabling uniform maintenance, monitoring, and control of all equipment.

In either architectural model, management functions can be limited for each NETCONF client managing an O-RU making for flexible operation. For example, operations can be divided into a NETCONF client performing SW management and a NETCONF client performing fault management.

Table 1　Overview of M-Plane functions

| Function name | Description |
|---|---|
| "Start up" installation | M-Plane startup procedure |
| SW management | O-RU SW management |
| Configuration management | O-RU parameter set/get |
| Performance management | Management of O-RU measurement items |
| Fault management | O-RU fault management |
| File management | Send/receive data files to/from O-RU |

*45 NMS: Generic name for a system or function performing management tasks in a network.

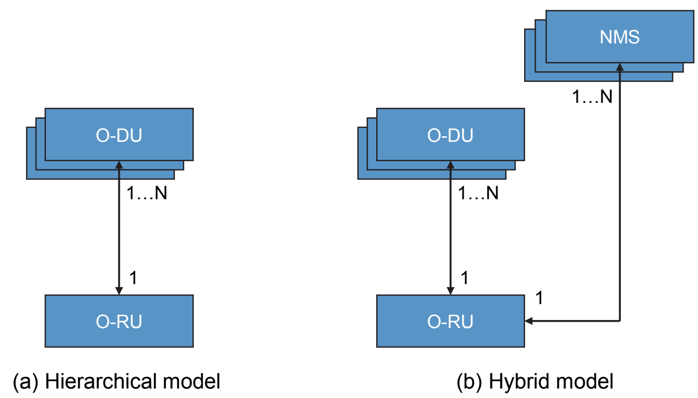


Figure 9 Architecture supporting M-Plane

2) M-Plane Functions

(a) "Start up" installation

"Start up" installation specifies the establishment of M-Plane connections between O-RU and NETCONF clients such as O-DU and NMS. Establishing these connections on the M-Plane requires mutual exchange of Transport Layer address*46 information.

For this function, O-RAN fronthaul specifications prescribe the following three options.

- Manual setting of Transport Layer addresses
- Allocation of Transport Layer addresses by a Dynamic Host Configuration Protocol (DHCP)*47 server
- Allocation of Transport Layer addresses by StateLess Address Auto-Configuration (SLAAC)*48 (when supporting IPv6)

In addition to the option of having maintenance personnel set Transport Layer addresses beforehand, support is also provided for a plug-and-play method of address resolution using a DHCP server, SLAAC, etc.

(b) SW management

An O-DU/NMS NETCONF client performs O-RU SW management via the M-Plane. In multivendor RAN, a NETCONF client of a certain vendor must manage the SW files of an O-RU heavily dependent on another vendor's implementation, so a mechanism of SW management that is independent of O-RU-implementation or vendor is important.

The main SW management procedure is as follows:

(1) SW inventory
(2) SW download
(3) SW installation
(4) SW activation

*46 Transport Layer address: Information such as an IP address required for establishing a connection on the Transport Layer.

*47 DHCP: A protocol used for automatically allocating information (e.g., IP addresses) to computers connected to networks.

*48 SLAAC: In IPv6, a protocol for automatically allocating information (e.g., IPv6 addresses) to computers connected to networks.

To begin with, the NETCONF client must get hold of the O-RU SW package provided by the O-RU vendor. In addition to the SW files needed for actual O-RU operation, this package should include a manifest file indicating which SW files should be installed in each O-RU. Such a manifest file is essential to achieving multivendor RAN.

The operation sequence is shown in **Figure 10**. First, in the SW inventory step, the NETCONF client gets information on what types of files are currently stored on the O-RU. This inventory information is compared with build-name/version and file-name/version information in the manifest file so that the NETCONF client can determine whether a download to the O-RU is necessary, and if so, which files should be designated for download. Depending on the manifest file formats specified in O-RAN fronthaul specifications, it is sufficient for the NETCONF client to compare only build-name/version and file-name/version information—there is no need to compare actual SW files dependent on the O-RU implementation. This enables SW management by NETCONF clients from different vendors. Continuing on, the management process instructs that the required SW files be downloaded to the O-RU and that those files be installed once the download completes. Finally, once installation completes, the process instructs that the SW files to be used at the next boot be activated.

(c) Configuration management

In this function, an O-DU/NMS NETCONF client sets O-RU parameters required on the

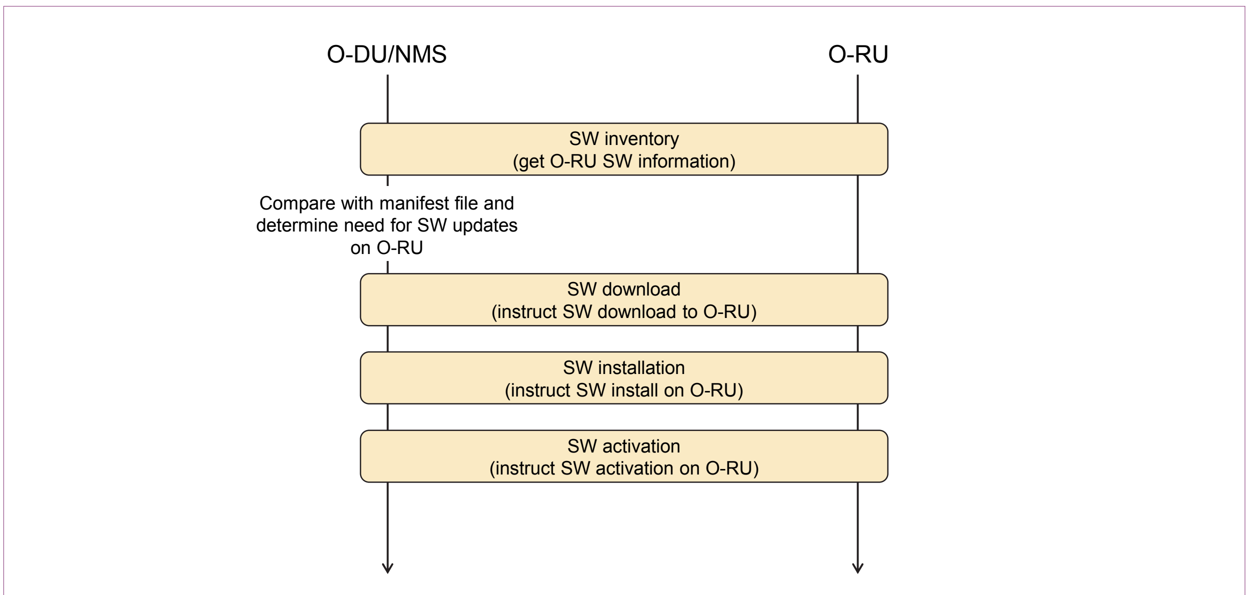


**Figure 10　SW management**

C/U-Plane and S-Plane and gets equipment status information via the M-Plane. This function is achieved using standard messages specified in NETCONF. The setting of required parameters is specified in the form of YANG modules and achieved in the following way.

In NETCONF, establishing a session*49 is accompanied by an exchange of <hello> messages. Each of these messages contains the NETCONF functions supported by that equipment and information on supported YANG modules. This enables the O-DU/NMS NETCONF client to determine what YANG modules are supported by the O-RU. NETCONF specifies <edit-config> and <get-config> as standard messages for setting parameters and getting parameter values, respectively. Sending these messages to an O-RU makes it possible to set various types of parameters and to get information on the parameters stored on the O-RU and the status of that equipment.

(d) Fault management

An NETCONF client manages O-RU faults via the M-Plane. In this function, the O-RU sends a notification to the O-DU/NMS NETCONF client using <notification> specified as a standard message in NETCONF. In the event of some sort of problem on the O-RU side such as an equipment fault, the O-RU notifies the NETCONF client of the fault together with the following detailed information.

- ID
- Location of fault occurrence
- Locations affected by fault
- Severity of fault
- New fault occurrence or a fault that has already been resolved

## 3.5 Fronthaul Network Topologies

Taking into account limitations on the number of physical lines between O-DU and O-RU, there may be cases when the fronthaul needs to take on network topologies other than point-to-point (**Figure 11** (a)) such as those using a Layer 2 switch*50. The C/U/S-Plane and M-Plane described above supports such network topologies as shown by the following examples (Fig. 11 (b)).

For example, case (1) in the figure depicts a topology in which the number of fronthaul lines can be different in each interval. This topology can be used to increase the fronthaul transmission capacity without having to increase the capacity per port of the O-DU and O-RU by simply increasing the number of ports each having the standard amount of capacity. In addition, this topology allows for only one line to be used between L2 switches, which can help keep line costs down.

Next, case (2) in the figure depicts a topology that gives redundancy to the fronthaul path between O-DU and O-RU. If either of the paths shown fails, this topology enables services to be continued via equipment using the other path.

Finally, case (3) in the figure depicts a topology that enables many O-RUs to be simultaneously connected by using the switch as a hub even if the number of physical ports on the O-DU should be limited.

*49 Session: A series of communications exchanged between a client and server.

*50 Layer 2 switch: A network device that assesses the MAC address included in a packet and relays that packet accordingly.

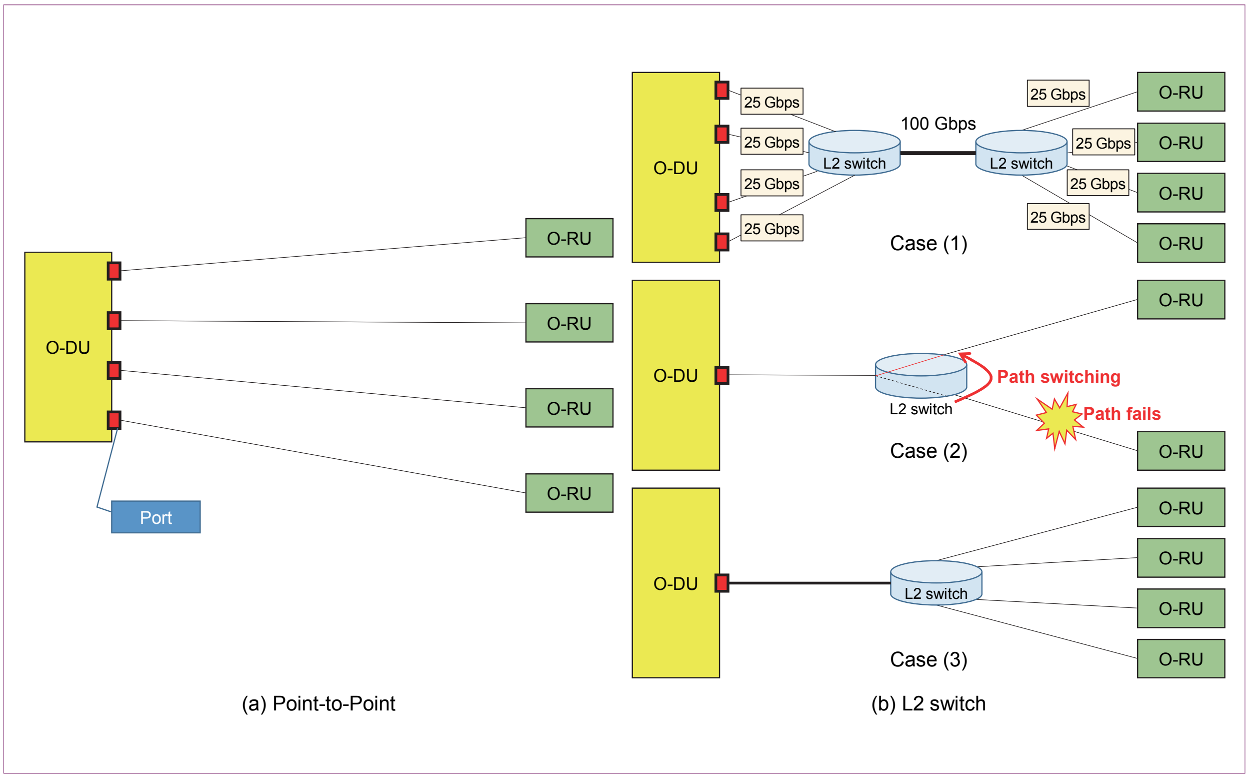


Figure 11　Examples of fronthaul topologies

## 4. Conclusion

This article introduced Split Option 7-2x adopted in O-RAN fronthaul specifications and described the C/U/S-Plane and M-Plane prescribed in the same specifications. Going forward, the O-RAN Alliance will continue to promote genuine multivendor RAN using O-RAN fronthaul specifications and to make useful extensions to those specifications. For its part, NTT DOCOMO will continue to support the activities of the O-RAN Alliance such as by drafting a multivendor RAN profile (compilation of fronthaul topologies, parameter settings, etc. for achieving interoperability in a multivendor environment).

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