International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.872

Amendment 2

(07/2010)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital networks – Optical transport networks

Architecture of optical transport networks

Amendment 2

Recommendation ITU-T G.872 (2001) – Amendment 2

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Recommendation ITU-T G.872

Architecture of optical transport networks

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Summary

Amendment 2 to Recommendation ITU-T G.872 provides modifications to clause 9 to describe the resources used to convey ODUk signals as a single layer network. This revised clause also describes the new 1.25 Gbit/s TS structure and some considerations on interworking with the existing 2.5 Gbit/s. The new ODUk signals, e.g., ODU0, ODU4 and ODUflex are also described. A new Appendix IV describes some multi-domain network examples.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.872	1999-02-26	13
2.0	ITU-T G.872	2001-11-29	15
2.1	ITU-T G.872 (2001) Amend. 1	2003-12-14	15
2.2	ITU-T G.872 (2001) Cor. 1	2005-01-13	15
2.3	ITU-T G.872 (2001) Amend. 2	2010-07-29	15

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

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1) Clause 9.1, Introduction

Update this clause with the additions and deletions noted below:

Furthermore, due to the limitations of the current optical technology it is not possible to build a worldwide pure optical network. 3R regeneration of the optical channel signals is required after a certain distance and it will be used at domain borders in order to decouple the domains concerning optical signal impairments and to get an accurate assessment of the signal quality.

For this reason ITU-T Rec. G.709 ~~chose to~~ implements the Optical Channel by means of a digital framed signal with digital overhead that supports the management requirements for the OCh listed in clause 6. Furthermore this allows the use of Forward Error Correction for enhanced system performance. An optical channel may support a single client mapped into an ODU. In addition, in order to allow transport of several lower bit-rate ODUs over a higher bit-rate optical channel and maintain the end-to-end trail for these lower bit-rate channels, time division multiplexing (TDM) of ODUs is defined. Client signals are mapped into server ODUs, these ODUs are either mapped directly into an OTU, or multiplexed as a client into a server ODU. This results in a 1:1:1 relationship between the ODU, OTU and OCh. Each ODU has a defined number of tributary slots (TS) at either a bit-rate of nominally 1.25 Gbit/s or 2.5 Gbit/s. Client ODUs which are mapped into server ODUs are mapped into the required number of TSs. This results in the introduction of two digital layer networks, the ODU and OTU. ~~The intention is that all client signals would be mapped into the Optical Channel via the ODU and OTU layer networks.~~

~~In order to allow optimization of the OTN for different applications, ODU and OTU signals for three bit rate areas are defined:~~

- ~~ODU1 and OTU1 for the 2.5 Gbit/s bit-rate area;~~
- ~~ODU2 and OTU2 for the 10 Gbit/s bit-rate area;~~
- ~~ODU3 and OTU3 for the 40 Gbit/s bit-rate area.~~

~~Support for entities at higher bit rates is for further study.~~

~~In the meantime, the desire remains for this Recommendation to describe an Optical Channel without any digital processing, so that this Recommendation remains valid should technology become available that allows for the implementation of this Recommendation without digital processing. To this end, the Optical Channel requirements of this Recommendation remain in force, and the OTU could be considered just another client of the OCh.~~

~~Currently, the only client of the Optical Channel that meets all the requirements of this Recommendation is the OTU. Other clients can be directly mapped into the OCh, with a corresponding loss of functionality, and without support from any standard.~~

Insert the following new text at the end of clause 9.1:

Tables 9.1.1 and 9.1.2 enumerate the set of ODU and OTU signals at the time of publication, the full set of signals is provided by the current version of ITU-T G.709.

Table 9.1.1 – Set of ODU clients and their ODU servers

ODU clients	ODU servers
1.25 Gbit/s bit-rate area	ODU0
–	
2.5 Gbit/s bit-rate area	ODU1
ODU0	
10 Gbit/s bit-rate area	ODU2
ODU0, ODU1, ODUflex	
10.3125 Gbit/s bit-rate area	ODU2e
–	
40 Gbit/s bit-rate area	ODU3
ODU0, ODU1, ODU2, ODU2e, ODUflex	
100 Gbit/s bit-rate area	ODU4
ODU0, ODU1, ODU2, ODU2e, ODU4, ODUflex	
CBR clients from greater than 2.5 Gbit/s to 100 Gbit/s: or GFP-F mapped packet clients from 1.25 Gbit/s to 100 Gbit/s.	ODUflex
–	

Table 9.1.2 – ODU clients and their OTU servers

ODU clients	OTU servers
ODU0	–
ODU1	OTU1
ODU2	OTU2
ODU2e	–
ODU3	OTU3
ODU4	OTU4
ODUflex	–

2) Clause 9.2, Digital OTN layered structure

Update this clause with the additions and deletions noted below:

The digital OTN layered structure is comprised of digital path layer networks (ODU) and digital section layer networks (OTU).

An OTU section layer supports one ODU path layer ~~network~~ as client~~ layer.~~ and provides monitoring capability for the OCh. An ODU path layer may transport a heterogeneous assembly of ODU clients. The heterogeneous multiplexing hierarchy supports various network architectures, including those optimized to minimize stranded capacity, minimize managed entities, support carrier's carrier scenarios, and/or enable ODU0/ODUflex traffic to transit a region of the network that does not support these capabilities.

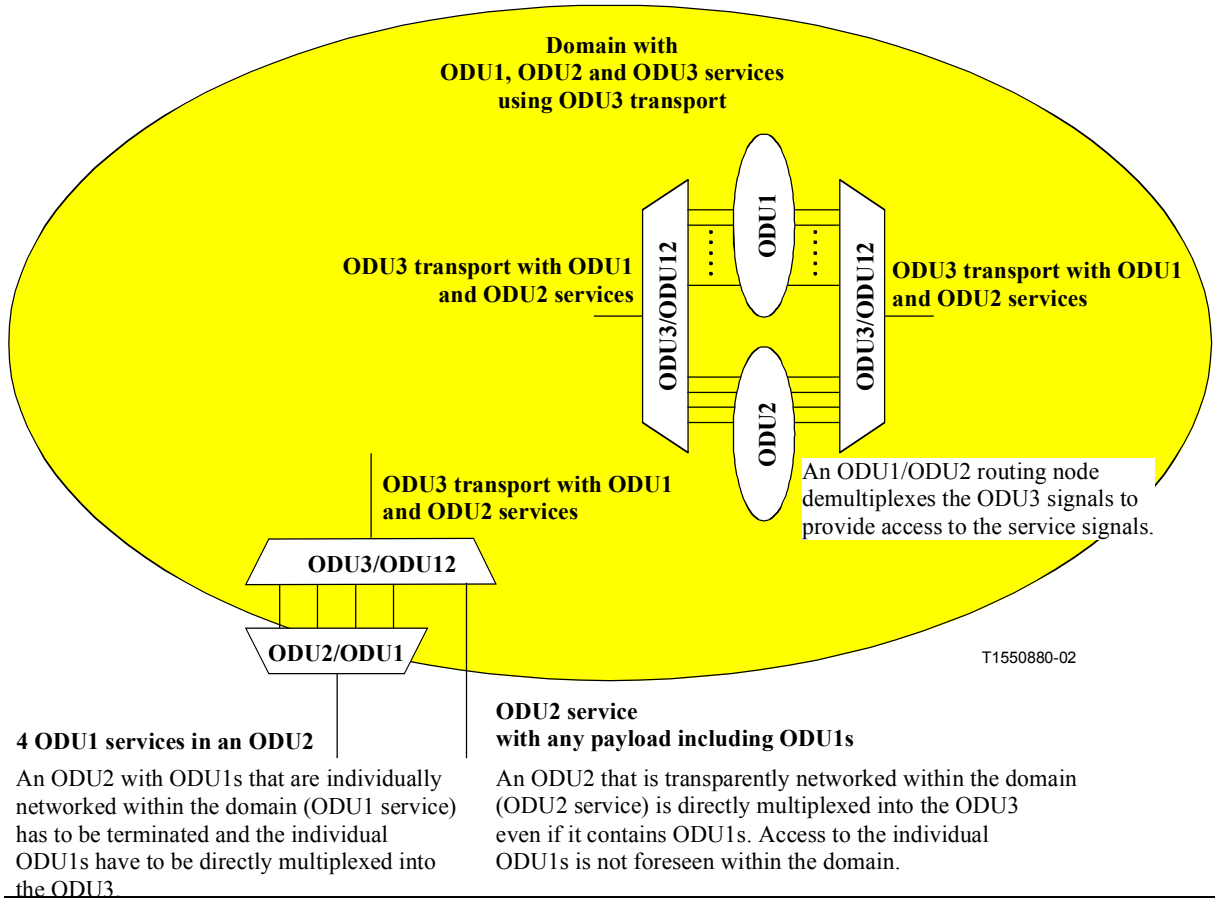
~~An ODU path layer supports the various OTN client signals and ODUj (j < k) path layer networks with lower bit rates (see ODU TDM in 9.6) as client layers. For the later case it is recommended that the number of visible hierarchical levels of ODU path layer networks that are supported within~~

~~a domain be limited to two (one multiplexing stage) in order to reduce the overall network complexity.~~

~~Example (see Figure 15): Within an administrative domain that supports ODU1 and ODU2 services over ODU3, only one-stage multiplexing (ODU1 → ODU2) or (ODU1, ODU2 → ODU3) is used. An ODU2 with ODU1 that are individually networked within the domain (ODU1 services) has to be terminated and the ODU1s have to be multiplexed directly into the ODU3 in case of transport via an ODU3. Transport of the ODU1s in the ODU2s via the ODU3 is not supported.~~

~~NOTE – This limitation does not apply to transparent transport of an ODU (e.g. ODU2 service) with any kind of client signals including lower bit rate ODUs (e.g. ODU1) over a higher bit rate ODU (e.g. ODU3) through a domain. Only if access to the lower bit rate ODUs (e.g. ODU1 service) is required within the domain does the limitation apply .~~

Figures 16 and 17 show the client/server relationships without and with ODU multiplexing.



~~Figure 15/G.872 – Visible hierarchical ODU path layer network levels within a domain~~

(Figure 15 has been deleted, Figures 16 – 28 have not been changed and have not been renumbered in this amendment.)

Motivation for this layer structure is as follows:

ODU layer network: This layer network provides functionality for end-to-end networking of digital path signals ~~for~~ that transparently convey~~ing~~ client information of varying format ~~(e.g. ATM, Ethernet, IP, SDH ATM, ODU, etc.)~~as described in Table 2. The description of supported client layer networks is outside the scope of this Recommendation. The topological components of the ODU layer network are subnetworks and links. The links are supported by an OTU trail or a server ODU trail. Since the resources that support these topological components support a heterogeneous assembly of ODUs, the ODU layer is modelled as a single layer network that is independent of bit-

rate. The ODU bit-rate is a parameter that allows the number of tributary slots (TS) for the ODU link connection to be determined. To provide end-to-end networking, the following capabilities are included in the layer network:

– ODU connection rearrangement for flexible network routing;

– ODU overhead processes for ensuring integrity of the ODU adapted information;

– ODU operations, administrations, and maintenance functions for enabling network level operations and management functions, such as connection provisioning, quality of service parameter exchange and network survivability.

OTU layer network: This layer network provides functionality for networking of digital section signals. It transparently conveys a single ODU client signal. The capabilities of this layer network include:

– OTU overhead processes and conditioning for the transport over optical channels for ensuring integrity of the OTU adapted information;

– OTU operations, administrations, and maintenance functions for enabling section level operations and management functions, such as OTU survivability.

The detailed functional description of the layer networks is given in the following clauses.

3) Clause 9.3, Optical channel layer network (OCh)

Update this clause with the additions and deletions noted below:

With the introduction of the ODU and OTU the OCh as described in 5.3 is limited to the analogue transport of the digital client payload signal (OTU) between 3R points of the OTN. It supports in this case only a subset (see Table 3) of the OCh management requirements defined in clause 6. The OCh only supports a single OTU.

4) Clause 9.6, ODU Time Division Multiplexing

Update this clause with the additions and deletions noted below:

~~Lower bit-rate~~ ODUj can be clients of ~~higher bit-rate~~an ODUk (k > j). Note that the ODUj may be an ODUflex. The TSs of the ODUk server may be allocated to any combination of ODUj clients up to the capacity of the ODUk. For the currently defined ODUks the following ~~client/server relationships are defined~~TSs are defined (see Table 9.6.1):

~~– An ODU2 can transport 4 ODU1s.~~

~~– An ODU3 can transport 16 ODU1s, or 4 ODU2s, or any mixture of ODU1 and ODU2 within these limits, where an ODU2 is the equivalent of 4 ODU1s.~~

~~For limitations on the number of visible hierarchical levels of ODU path layer networks within an domain, see 9.2.~~

Table 9.6.1 – Number of TSs for each ODUk

Nominal TS capacity	1.25 Gbit/s	2.5 Gbit/s
ODU1	2	1
ODU2	8	4
ODU3	32	16
ODU4	80	–

5) New clause 9.13, Multi-domain OTN

Add new clause 9.13 with the following text:

Domain A may have an OTN network comprised of client ODUi and server ODUj, i < j. The server ODUj may be carried over the network of domain B, interconnected by OTUj. Domain B may carry the ODUj as a client ODU over a server ODUk, j < k. Each of domain A and B sees two hierarchal ODU levels within their respective domains. The ODUj plays the role of a server ODU in domain A and the role of a client ODU in domain B.

A server ODUj of domain A can also be carried as a client ODUj in domain B directly over OTUj in domain B, using TCM to manage the segments of the ODUj path in each domain.

6) New Appendix IV: Examples of multi-domain OTN applications

Add new Appendix IV with the following text and figures:

This appendix provides examples of multi-domain OTN applications.

Figure IV.1 illustrates the case of interconnection of two disjoint domains (domain A) through another domain (domain B). Domain A has requested ODUi service from domain B. This ODUi service from domain A's perspective is a HO ODUi, carrying multiple LO ODUk signals. This same ODUi service from domain B's perspective is a LO ODUi of which the endpoints are outside the domain of domain B. Within domain B's network, the LO ODUi is carried over a HO ODUj.

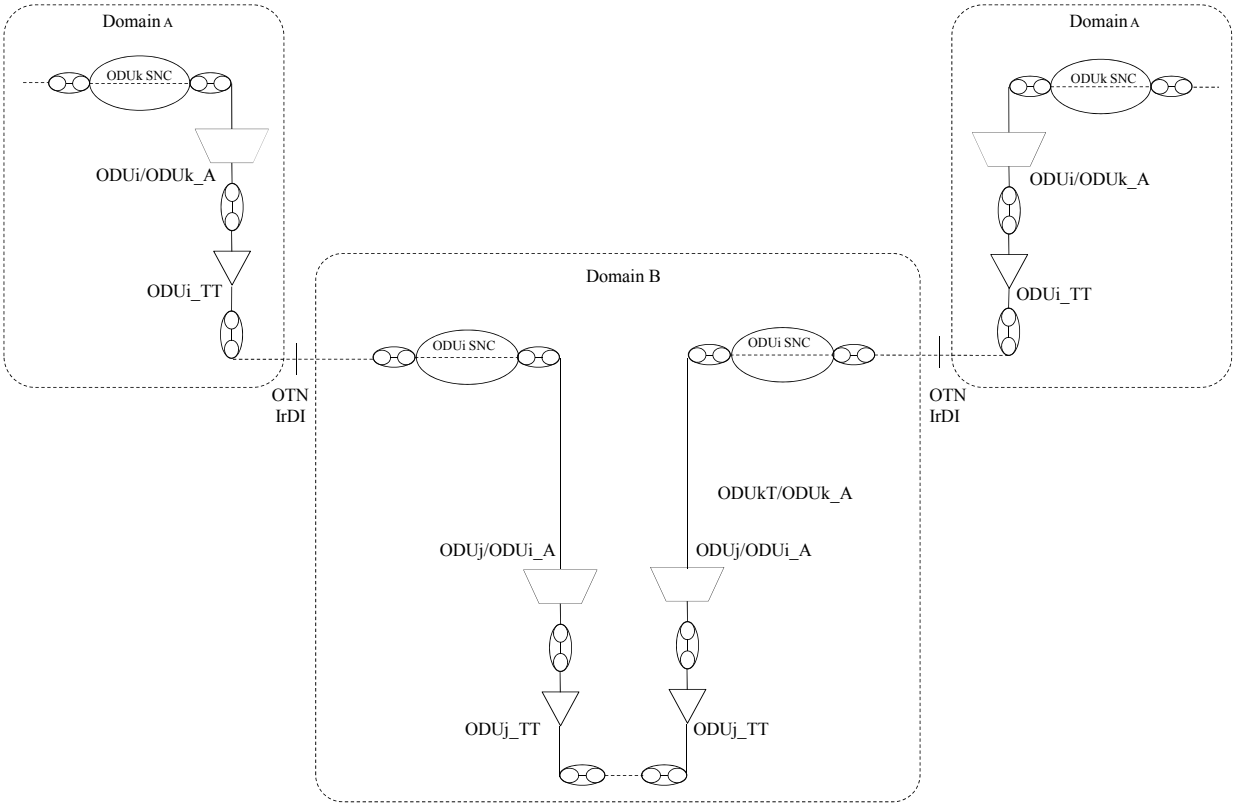


Figure IV.1 – Multi-domain OTN scenario 1

Figure IV.2 illustrates the above case with additional TCM function.

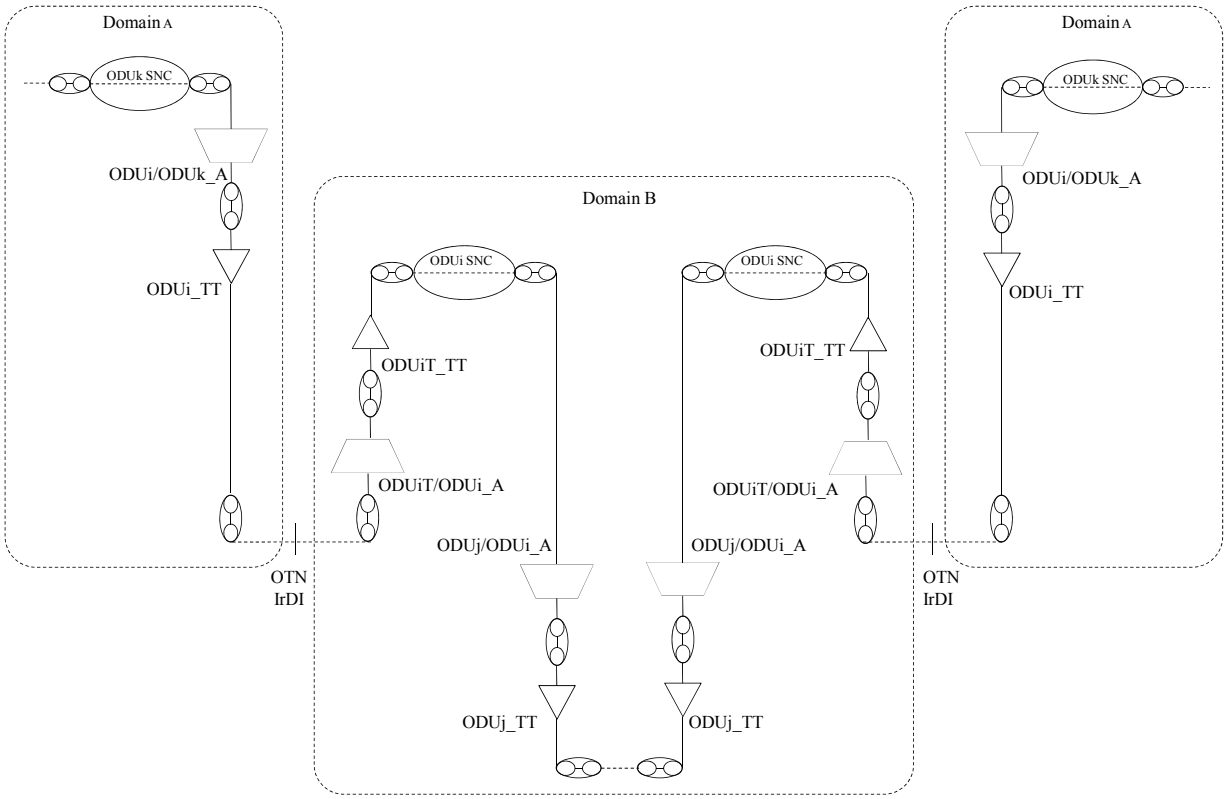


Figure IV.2 – Multi-domain OTN scenario 2

Figure IV.3 illustrates the case of server ODUi of domain A carried as a client ODUj in domain B directly over OTUj in domain B.

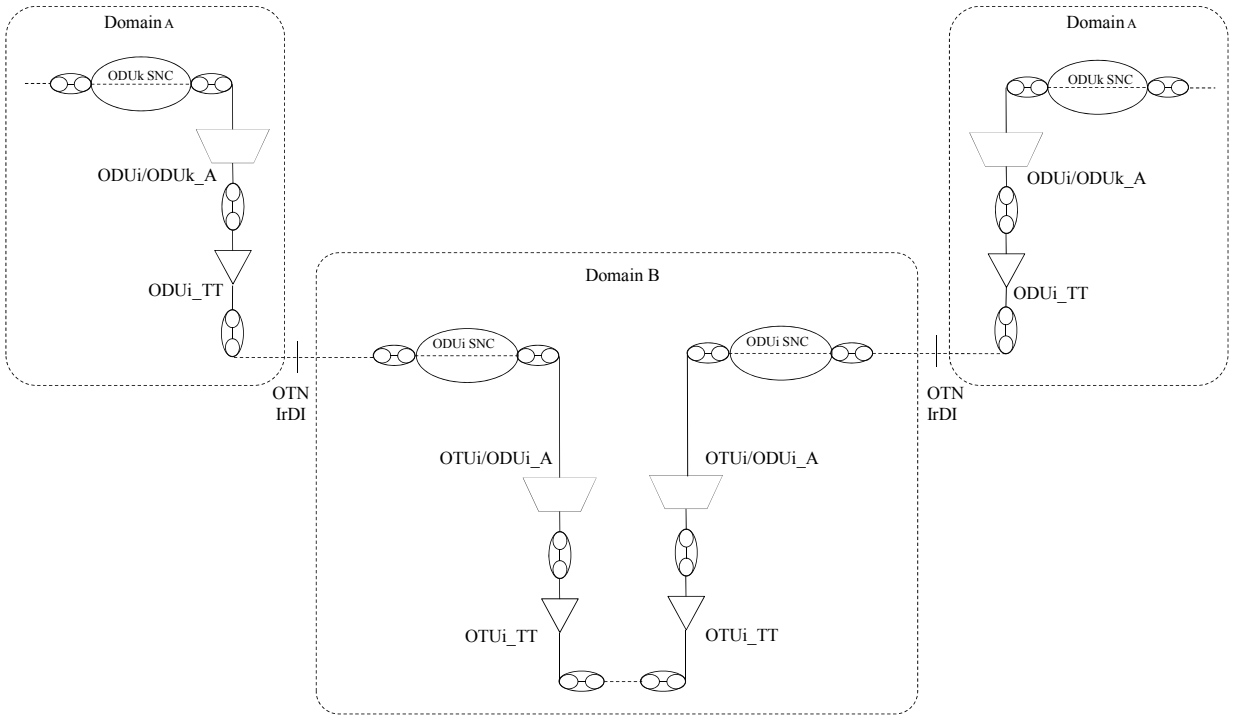


Figure IV.3 – Multi-domain OTN scenario 3

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