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

Digital networks – Management of transport network

Computational viewpoint for pre-provisioned route discovery

ITU-T Recommendation G.854.16

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ITU-T Recommendation G.854.16

Computational viewpoint for pre-provisioned route discovery

Summary

This computational viewpoint specification is related to the pre-provisioned route discovery enterprise and information specification. The objective of the community is to identify appropriate routes for setting up, or reserving the route components for (by using other communities), a trail, a tandem connection or a subnetwork connection. It is possible to request conditions that have to be met by the identified route. In addition to proposing routes, information is provided to help in the selection among the candidate route on the basis of a set of properties. In case of protection, the number of routes corresponds to the protection scheme chosen.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. 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.

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As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

CONTENTS

ITU-T Recommendation G.854.16

Computational viewpoint for pre-provisioned route discovery

1   Scope

This computational viewpoint specification is related to the pre-provisioned route discovery enterprise specification defined in ITU-T G.852.16 and the pre-provisioned route discovery information specification defined in ITU-T G.853.16.

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; all 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.

[1]   ITU-T G.851.1 (1996), *Management of the transport network – Application of the RM-ODP framework*.

[2]   ITU-T G.853.1 (1999), *Common elements of the information viewpoint for the management of a transport network*.

[3]   ITU-T G.852.16 (2001), *Enterprise viewpoint for pre-provisioned route discovery*.

[4]   ITU-T G.853.16 (2001), *Information viewpoint for pre-provisioned route discovery*.

[5]   ITU-T G.853.10 (1999), *Information viewpoint for pre-provisioned link connection management*.

[6]   ITU-T G.854.3 (1999), *Computational viewpoint for topology management*.

3   Definitions

No new term is defined in this Recommendation.

4   Abbreviations

This Recommendation uses the following abbreviations:

ASN.1   Abstract Syntax Notation One

CTP   Connection Termination Point

Id   Identifier

Ifce   Interface

inv   invariant

ITU-T   International Telecommunication Union – Telecommunication Standardization Sector

layerND   layerNetwork Domain

LC   LinkConnection

plcm   pre-provisioned link connection management

prd   pre-provisioned route discovery

Rec.   Recommendation

RM-ODP   Reference Model for Open Distributed Processing

TTP   Trail Termination Point

5   Conventions

In order to increase the readability of the behaviour in the operations:

•   parameters are written in **bold**;

•   elements defined in the information viewpoint specification are written in *italic*.

6   Label references

Full label reference	Local label reference
<"Rec. G.853.16", INFORMATION_OBJECT: prdAccessGroup>	prdAccessGroup
<"Rec. G.853.16", INFORMATION_OBJECT: prdLayerNetworkDomain>	prdLayerNetworkDomain
<"Rec. G.853.16", INFORMATION_OBJECT: prdLink>	prdLink
<"Rec. G.853.16", INFORMATION_OBJECT: prdLinkConnection>	prdLinkConnection
<"Rec. G.853.16", INFORMATION_OBJECT: prdLinkEnd>	prdLinkEnd
<"Rec. G.853.16", INFORMATION_OBJECT: prdNetworkTTP>	prdNetworkTTP
<"Rec. G.853.16", INFORMATION_OBJECT: prdNetworkCTP>	prdNetworkCTP
<"Rec. G.853.16", INFORMATION_OBJECT: prdRoutingConditions>	prdRoutingConditions
<"Rec. G.853.16", INFORMATION_OBJECT: prdRoute>	prdRoute
<"Rec. G.853.16", INFORMATION_OBJECT: prdRouteSet>	prdRouteSet
<"Rec. G.853.16", INFORMATION_OBJECT: prdSubnetwork>	prdSubnetwork
<"Rec. G.853.16", INFORMATION_OBJECT: prdTopologicalLink>	prdTopologicalLink
<"Rec. G.853.16", INFORMATION_OBJECT: prdTopologicalLinkEnd>	prdTopologicalLinkEnd
<"Rec. G.853.1", INFORMATION_RELATIONSHIP: layerNetworkDomainIsMadeOf>	layerNetworkDomainIs MadeOf
<"Rec. G.853.16", INFORMATION_RELATIONSHIP: prdRouteFulfillsRoutingConditions>	prdRouteFulfillsRouting Conditions
<"Rec. G.853.16", INFORMATION_RELATIONSHIP: prdRouteSetHasRoutes>	prdRouteSetHasRoutes
<"Rec. G.853.1", INFORMATION_ATTRIBUTE: directionality>	directionality
<"Rec. G.853.1", INFORMATION_ATTRIBUTE: linkDirectionality>	linkDirectionality
<"Rec.G.853.10", INFORMATION_ATTRIBUTE: plcmCallerId>	plcmCallerId
<"Rec. G.853.1", INFORMATION_ATTRIBUTE: pointDirectionality>	pointDirectionality
<"Rec.G.853.16", INFORMATION_ATTRIBUTE: prdArc-Point-orientedRouteComponents>	prdArc-Point-orientedRouteComponents

Full label reference	Local label reference
<"Rec.G.853.16", INFORMATION_ATTRIBUTE: prdReturnedProperties>	prdReturnedProperties
<"Rec.G.853.16", INFORMATION_ATTRIBUTE: prdRouteEnds>	prdRouteEnds
<"Rec.G.853.16", INFORMATION_ATTRIBUTE: prdIndividualRouteComponentsList>	prdIndividualRouteComponents List
<"Rec. G.853.1", INFORMATION_ATTRIBUTE: resourceId>	resourceId
<"Rec.G.853.1", INFORMATION_ATTRIBUTE: signalIdentification>	signalIdentification
<"Rec.G.853.1", INFORMATION_ATTRIBUTE: topologicalEndDirection>	topologicalEndDirection
<"Rec. G.853.1", INFORMATION_ATTRIBUTE: userLabel>	userLabel
<"Rec. G.854.3", INTERFACE: commonReportResourceIdChangeIfce>	commonReportResourceId ChangeIfce
<"Rec. G.854.3", INTERFACE: commonResourceIfce>	commonResourceIfce

Full ASN.1 production reference	Local label reference
<"Rec. X.721:1992: Attribute-ASN.1 Module": SimpleNameType>	SimpleNameType
<"Rec. X.680:1997: GraphicString">	GraphicString

7 Interfaces

This Recommendation does not define operations which change the userLabel of the resources or report this change to the notification receiver (these operations are defined in the superclass interfaces defined in ITU-T G.854.3 and used in this Recommendation) because they do not change the state of the system. There exact signature will be developed as part of the engineering viewpoint specification with the concerned technology.

7.1 Query interfaces

This Recommendation refers to interfaces that allow access to identification and properties of resources involved in the "pre-provisioned route discovery" community. As the invocation of contained operations does not modify any state, there is no interest in developing them explicitly. Their exact signature will be developed as part of the engineering viewpoint, with the concerned technology. These interfaces are listed in the following table with the information they allow access to.

Interface name	Information object	Attributes and relationships
prdAccessGroupQueryIfce	\<prdAccessGroup\>	\<resourceId\> \<signalIdentification\> \<topologicalEndDirection\> \<layerNetworkDomainIsMadeOf, ROLE: containerLND\>
prdLayerNetworkDomainQueryIfce	\<prdLayerNetworkDomain\>	\<resourceId\> \<signalIdentification\> \<layerNetworkDomainIsMadeOf, ROLE: element\>
prdLinkConnectionQueryIfce	\<prdLinkConnection\>	\<resourceId\> \<signalIdentification\> \<directionality\> \<userLabel\> \<plcmCallerId\> \<layerNetworkDomainIsMadeOf, ROLE: containerLND\>
prdLinkEndQueryIfce	\<prdLinkEnd\>	\<resourceId\> \<signalIdentification\> \<topologicalEndDirection\> \<layerNetworkDomainIsMadeOf, ROLE: containerLND\>
prdLinkQueryIfce	\<prdLink\>	\<resourceId\> \<signalIdentification\> \<linkDirectionality\> \<layerNetworkDomainIsMadeOf, ROLE: containerLND\>
prdNetworkCTPQueryIfce	\<prdNetworkCTP\>	\<resourceId\> \<signalIdentification\> \<pointDirectionality\> \<userLabel\> \<plcmCallerId\> \<layerNetworkDomainIsMadeOf, ROLE: containerLND\>
prdNetworkTTPQueryIfce	\<prdNetworkTTP\>	\<resourceId\> \<signalIdentification\> \<pointDirectionality\> \<layerNetworkDomainIsMadeOf, ROLE: containerLND\>
prdRouteSetQueryIfce	\<prdRouteSet\>	\<resourceId\> \<prdRouteEnds\> \<layerNetworkDomainIsMadeOf, ROLE: containerLND\> \<prdRouteSetFulfillsRouting Conditions, ROLE: fulfilledConditions\> \<prdRouteSetHasRoutes, ROLE: route\>

Interface name	Information object	Attributes and relationships
prdRouteQueryIfce	<prdRoute>	<resourceId> <prdIndividualRouteComponents List> <prdReturnedProperties> <layerNetworkDomainIsMadeOf, ROLE: containerLND> <prdRouteSetHaseRoutes, ROLE: routeSet>
prdRoutingConditionsQueryIfce	<prdRoutingConditions>	<resourceId> <prdArc-Point-orientedRouteComponents> <prdRouteSetFulfillsRouting Conditions, ROLE: routeSet>
prdSubnetworkQueryIfce	<prdSubnetwork>	<resourceId> <signalIdentification> <layerNetworkDomainIsMadeOf, ROLE: containerLND>
prdTopologicalLinkEndQueryIfce	<prdTopologicalLinkEnd>	<resourceId> <signalIdentification> <topologicalEndDirection> <layerNetworkDomainIsMadeOf, ROLE: containerLND>
prdTopologicalLinkQueryIfce	<prdTopologicalLink>	<resourceId> <signalIdentification> <linkDirectionality> <layerNetworkDomainIsMadeOf, ROLE: containerLND>

7.2   Operational interfaces

7.2.1   Route discovery interface

The route discovery interface provides functionality for retrieving potential routes that can be used when setting up trails, tandem connections or subnetwork connections as defined in <"Rec. G.852.16", COMMUNITY: pre-provisioned route discovery>.

```
COMPUTATIONAL INTERFACE routeDiscoveryIfce{
    DERIVED FROM <commonResourceIfce>
    OPERATION {
            <discoverRoutes>;
    }
}
```

Discover routes

<COMMUNITY: pre-provisioned route discovery, ACTION: discover routes>
OPERATION discoverRoutes {
   INPUT_PARAMETERS
     routeEnds: RouteEnds ::= SEQUENCE OF {
              aEnd AEndChoice,
              zEnd ZEndChoice};
                    -- one aEnd/zEnd pair is sufficient to represent the ends of all the routes
          suppliedRoutingConditions: SuppliedRoutingConditions
                    -- the ASN.1 type for suppliedRoutingConditions will be developed in technology
                    -- specific extensions of the route discovery community
          arcOrPointOrientedRouteComponents: ArcPointOriented;
          layerND: LayerNetworkDomainChoice;
          routeDir: RouteDirChoice ::= CHOICE {
              dir   Directionality,
              linkDir   LinkDirectionality,
              pointDir   PointDirectionality,
              topologicalEndDir   TopologicalEndDirectionality};
          suppliedUserIdentifier: UserIdentifier;

   OUTPUT_PARAMETERS
          routeSet: ReturnedRouteSet ::= SET OF ReturnedRoute;
          routeEnds: RouteEnds

                    -- the ASN.1 type for ReturnedRoute will be developed in technology
                    -- specific extensions of the pre-provisioned route discovery community

   RAISED_EXCEPTIONS
          invalidRouteEnds: routeEnds;
          routingConditionsNotAssociated: SuppliedRoutingConditions;
          newRouteComponentsNotPartOfLND: SET OF RouteComponents;
          newRouteComponentsNotFree: SET OF RouteComponents;
          routeComponentsNotConsistent: NULL;

BEHAVIOUR
SEMI_FORMAL

   PARAMETER_MATCHING
          accessGroup: < INFORMATION OBJECT: prdAccessGroup>;
          link: < INFORMATION OBJECT: prdLink>;
          linkConnection: < INFORMATION OBJECT: prdLinkConnection>;
          linkEnd : < INFORMATION OBJECT: prdLinkEnd>;
          networkCTP: < INFORMATION OBJECT: prdNetworkCTP>;
          networkTTP: < INFORMATION OBJECT: prdNetworkTTP>;
          subnetwork: <INFORMATION OBJECT: prdSubnetwork>;
          topologicalLink: < INFORMATION OBJECT: prdTopologicalLink>;
          topologicalLinkEnd: < INFORMATION OBJECT: prdTopologicalLinkEnd>;
          suppliedRoutingConditions: < INFORMATION OBJECT: prdRoutingConditions>;
          arcOrPointOrientedRouteComponents: <INFORMATION ATTRIBUTE: prdArc-Point-
          orientedRouteComponents>;
          layerND: <INFOMATION OBJECT: prdLayerNetworkDomain>;
          suppliedUserIdentifier: <INFORMATION ATTRIBUTE: resourceId>;
          routeSet: <INFORMATION OBJECT: prdRouteSet>;
          routeEnds: <INFORMATION ATTRIBUTE: prdRouteEnds>;

          dir : < INFORMATION ATTRIBUTE: directionality > ;
          linkDir: < INFORMATION ATTRIBUTE: linkDirectionality>;
          topologicalEndDir: <INFORMATION ATTRIBUTE: topologicalEndDirectionality>;

          pointDir : < INFORMATION ATTRIBUTE: pointDirectionality > ;

PRE_CONDITIONS
    inv_routeEndsLNDContainment
        "The elements representing the aEnd and zEnd of the routeEnds are referring to *element* in the *<layerNetworkDomainIsMadeOf>* relationship where layerND refers to *containerLND*."

    POST_CONDITIONS
    inv_associatedWithSuppliedRoutingConditions
        "The suppliedRoutingConditions have to participate in the *<prdRouteSetFulfillRoutingConditions>* relationship taking the *fulfilledConditions* role while routeSet is taking on the *routeSet* role."
    inv_newRouteComponentsLNDContainment
        "All route components of routeSet must refer to *element* in the *<layerNetworkDomainIsMadeOf>* relationship where layerND refers to *containerLND*."
    inv_freeNewRouteComponents
        "*<plcmCallerId>* of all route components contained in routeSet must be equal to NULL."
    inv_consistentRouteComponents
        "Only linkConnections are allowed as route components in routeSet when arcOrPointOrientedRouteComponents is equal to arc-oriented. Only networkCTPs are allowed as route components in routeSet when arcOrPointOrientedRouteComponents is equal to point-oriented."

    EXCEPTIONS
    IF PRE_CONDITION inv_routeEndsLNDContainment NOT_VERIFIED RAISE_EXCEPTION invalidRouteEnds;
    IF POST_CONDITION inv_associatedWithSuppliedRoutingConditions NOT_VERIFIED RAISE_EXCEPTION routingConditionsNotAssociated;
    IF POST_CONDITION inv_newRouteComponentsLNDContainment NOT_VERIFIED RAISE_EXCEPTION newRouteComponentsNotPartOfLND;
    IF POST_CONDITION inv_freeNewRouteComponents NOT_VERIFIED RAISE_EXCEPTION newRouteComponentsNotFree;
    IF POST_CONDITION inv_consistentRouteComponents NOT_VERIFIED RAISE_EXCEPTION routeComponentsNotConsistent;
;}

7.3 Reporting interfaces

7.3.1 Route discovery reporting interface

The route discovery reporting interface provides functionality for the reporting of the retrieving of potential routes that can be used for setting up trails, tandem connections or subnetwork connections as defined in <"Rec. G.852.16", COMMUNITY: pre-provisioned route discovery>.

```
COMPUTATIONAL INTERFACE routeDiscoveryReportingIfce{
    DERIVED FROM <commonResourceIdChangeIfce>
    OPERATION {
        <reportRouteDiscovery>;
    }
}
```

Route discovery reporting

```
<COMMUNITY: pre-provisioned route discovery, ACTION: report route discovery>
OPERATION reportRouteDiscovery {
    INPUT_PARAMETERS
        layerND: LayerNetworkDomainChoice;
        routeSet: ReturnedRouteSet ::= SET OF ReturnedRoute;
        routeEnds: RouteEnds
                    -- the ASN.1 type for ReturnedRoute will be developed in technology
                    -- specific extensions of the pre-provisioned route discovery community

    OUTPUT_PARAMETERS
        -- none
```

RAISED_EXCEPTIONS
            -- none

BEHAVIOUR
SEMI_FORMAL

        PARAMETER_MATCHING
            layerND: <INFOMATION OBJECT: prdLayerNetworkDomain>;
            routeSet: <INFORMATION OBJECT: prdRouteSet>;
            routeEnds: <INFORMATION ATTRIBUTE: prdRouteEnds>;

        TRIGGERING_CONDITIONS
        PRE_CONDITIONS
            inv_noRouteSet
                " routeSet does not refer to any *element* in the the *<layerNetworkDomainIsMadeOf>*
                relationship where layerND refers to *containerLND*."

        POST_CONDITIONS
            inv_existingRouteSet
                " routeSet does refer to *element* in the the *<layerNetworkDomainIsMadeOf>* relationship
                where layerND refers to *containerLND*."
EXCEPTIONS
            -- none

;}

7.4   ASN.1 supporting productions

In this Recommendation, when an interface name is used within an ASN.1 production, the same label will be used, starting with a capital letter. The complete ASN.1 type definition for this query interface (e.g. use of ObjectIdentifier, INTEGER, ...) will be developed as part of the engineering viewpoint, with the concerned technology.

```
AccessGroupChoice ::= CHOICE {
      prdAccessGroupQueryIfce    PrdAccessGroupQueryIfce,
      userIdentifier             UserIdentifier };


AEndChoice ::= CHOICE {
      networkTTPChoice           NetworkTTPChoice,
      networkCTPChoice           NetworkCTPChoice,
      linkConnectionChoice       LinkConnectionChoice,
      accessGroupChoice          AccessGroupChoice,
      linkChoice                 LinkChoice,
      linkEndChoice              LinkEndChoice,
      topologicalLinkChoice      TopologicalLinkChoice,
      topologicalLinkEndChoice   TopologicalLinkEndChoice,
      subnetworkChoice           SubnetworkChoice};

ArcPointOriented ::= CHOICE {
      arc                        NULL,
      point                      NULL};

LayerNetworkDomainChoice ::= CHOICE {
      prdLayerNetworkDomainQueryIfce     PrdLayerNetworkDomainQueryIfce,
      userIdentifier                     UserIdentifier};

LinkChoice ::= CHOICE {
      prdLinkQueryIfce           PrdLinkQueryIfce,
      userIdentifier             UserIdentifier};
```

```
LinkConnectionChoice ::= CHOICE {
      prdLinkConnectionQueryIfce          PrdLinkConnectionQueryIfce,
      userIdentifier                      UserIdentifier};

LinkEndChoice ::= CHOICE {
      prdLinkEndQueryIfce                 PrdLinkEndQueryIfce,
      userIdentifier                      UserIdentifier};

NetworkCTPChoice ::= CHOICE {
      prdNetworkCTPQueryIfce              PrdNetworkCTPQueryIfce,
      userIdentifier                      UserIdentifier};

NetworkTTPChoice ::= CHOICE {
      prdNetworkTTPQueryIfce              PrdNetworkTTPQueryIfce,
      userIdentifier                      UserIdentifier};


ProtectionScheme ::= CHOICE {
      noProtection                        NULL,
      1+1_Protection                      NULL,
      1:n_Protection                      NULL,
      m:n_Protection                      NULL};

ReturnedProperties :: SET OF {
      property1                 Property1
      ....
      propertyN                 PropertyN};
            -- the ASN.1 type for ReturnedProperties will be developed in technology
            -- specific extensions of the pre-provisioned route discovery community

ReturnedRoute ::= SEQUENCE OF {
      route                           PrdRouteQueryIfce;

      routeProperties                 ReturnedProperties,
       -- 0 implies none supplied
      routeComponents                 SEQUENCE OF RouteComponents};
                -- the number of the SEQUENCE OF in routeComponents corresponds to the protection scheme requested
                -- the final ASN.1 type for ReturnedRoute will be developed in technology specific extensions

RouteComponents ::= CHOICE {
      arcView                         SEQUENCE OF LinkConnectionChoice,
      pointView                       SEQUENCE OF NetworkCTPChoice;


SubnetworkChoice ::= CHOICE {
      prdSubnetworkQueryIfce          PrdSubnetworkQueryIfce
      userIdentifier                  UserIdentifier};

SuppliedRoutingConditions ::= SET OF {
      topologyCriteria                      TopologyComponentCriteria,
      maximumNumberOfNodes                  INTEGER,
      bandwidthConstraints                  INTEGER,
      protectionScheme                      ProtectionScheme,
      .....
                                      };
            -- banwidth constraints requests the maximum average spare capacity and shall be expressed in %
            -- the ASN.1 type for suppliedRoutingConditions will be developed in technology specific extensions

TopologicalLinkChoice ::= CHOICE {
      prdTopologicalLinkQueryIfce           PrdTopologicalLinkQueryIfce,
      userIdentifier                        UserIdentifier};
```

```
TopologicalLinkEndChoice ::= CHOICE {
      prdTopologicalLinkEndQueryIfce          PrdTopologicalLinkEndQueryIfce,
      userIdentifier                          UserIdentifier};

TopologyComponentCriteria :: SET OF {
      criteria1                               Criteria1
      ....
      criteriaN                               CriteriaN};
            -- the ASN.1 type for TopologyComponentCriteria will be developed in technology
            -- specific extensions of the pre-provisioned route discovery community

UserIdentifier ::= SimpleNameType;

ZEndChoice ::= CHOICE {
      networkTTPChoice              NetworkTTPChoice,
      networkCTPChoice              NetworkCTPChoice,
      linkConnectionChoice          LinkConnectionChoice,
      accessGroupChoice             AccessGroupChoice,
      linkChoice                    LinkChoice,
      linkEndChoice                 LinkEndChoice,
      topologicalLinkChoice         TopologicalLinkChoice,
      topologicalLinkEndChoice      TopologicalLinkEndChoice,
      subnetworkChoice              SubnetworkChoice };
```

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