Introduction to PON NE Management Functions and Operation Interfaces

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Agenda

• Introduction – in the old days (CMIP, GDMO)

• GE-PON and NE-OpS functions

• Operation Interfaces for other system
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In the latter of 1990’s, NTT deployed the FTTH services in some partial areas, and the FTTC services nationwide.

STM: synchronous transfer mode
SCM: subcarrier multiplexing
WDM: wavelength division multiplexing
POTS: plain old telephone service
ISDN: integrated service digital network
FTTC: fiber to the curb
Operation Systems Configuration

- Open and standard telecommunication management environment
- Concept based on TMN and OSI
- Interoperability among different vendor’s products inside TMN area

Full supports for OAN operations
  - Configuration management
  - Resource management
  - Service provisioning
  - Fault management

WS: workstation
OAN: optical access network
OS: operations system
NEMF: network element management function

TMN: telecommunication management network
OSI: open system interconnection
Interconnection with the existing system

Requirements to introduce TMN-based systems at that time:
- To provide interoperable interfaces for the existing OS
- To provide flow-through operations similar for existing other NEs

- protocol and Information translation
- polling to NEs
- additional error handling for example, analyzing protocol specific error checking hardware version for specific functions
Model for Configuration Management

- Containment tree (simplified example)
  - Containment relationship is available for representing a management model.
  - The full-path description combining instance-IDs from the top of the tree to the target instance indicates an unique position of the target object instance.
Model for Network Resource Management

These managed objects and other all objects also appear on the containment tree.

OSU: Optical Subscriber Unit
XC: cross connection
Managed object and X.500 Directory

- X.500 Directory Service
  - address resolution
- Transparency for each managed object
  - The directory knows addresses of top objects.
  - A manager knows the name and the containment tree of the agent.
  - A manager can access to objects inside agents.

Directory Service

• name="mgr-020"
  addr=192.168.241.12+1207
• name="olt-001"
  addr=192.168.242.10+32843

register my address

OAN-OS

manager

oltmgr

pkgFunction(1)  pkgFunction(2)

section(1)  section(1)

NEMF

agent

olt

shelf

slot

pkg(1)  pkg(2)

onu(1)  onu(2)
Operation by CMIP communication

• GDMO and ASN.1 are used for modeling of managed objects.
• CMIP provides some operation services on managed objects.
  CREATE, DELETE, GET, CANCEL_GET, SET,
  ACTION, EVENT_REPORT
  Especially an ACTION is utilized as a remote functional invocation.

GDMO: guidelines for the definition of managed object
CMIP: common management information protocol
ASN.1: abstract syntax notation one

• CORBA was additionally introduced as a TMN management protocol for easy development and ensuring interoperability.
• Recommendations about framework, modeling guidelines, services and information models using CORBA are defined.
  (X.780, X780.1, Q.816, Q.816.1, M.3120)
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Summary of Gigabit Ethernet PON (GE-PON)

- IEEE 802.3ah standardized in 2004
- 1Gbits/s bidirectional transmission
- P2MP (point to multi point) discovery
  - find a newly attached ONU
- Logical Link as a virtual communication link
  - identified with LLID (logical link ID) which is uniquely assigned by P2MP discovery process
  - a single LLID per ONU

![Diagram of GE-PON]

- ONU: Optical Network Unit
- LLID: Logical Link ID
- GATE: Gateway
- P2MP Discovery
- OLT: Optical Line Terminal
- SNI: Service Node Interface
- UNI: User Network Interface
Summary of GE-PON(2)

• OAM
  - remote failure indication, remote loopback, link monitoring
  - extensible but outside the scope of 802.3ah (Organization Specific OAM frame)
• MPCP (Multi-Point Control Protocol)
  - P2MP discovery, Report and Gate
  - upstream bandwidth control logic is out of scope of the 802.3ah
• DBA (dynamic bandwidth allocation)
  - one of the bandwidth control logic
Management Model inside the NE-OpS

• GE-PON itself is very simple from the management viewpoint.
• Input ether-frames are outputted without transformed.

Coarse-grained modeling may be applicable. Management information will be simply treated as attributes of objects such as olt, pon-if or onu(logical link).

• What kinds of functions should be provided?
• How will the operation procedure of this system become?
Study on required functions for GE-PON NE-OpS

- The GE-PON NE is a new type of equipment. Although its management information may be technology specific, it belongs to the same category of the PON NE.

- It is important to keep operation processes similar to that for existing other NEs, when introducing a new system.

- It is important to analyze previous systems, because they may have realized requirements from operators.

  Checking the conventional operation processes will be applicable.
Initial Installation \(\sim\) path setup

- initial installation of the OLT (shelf and CONT)
  - NE-OpS has nothing to do in this stage.
  - initial settings into the NE directly: network, security

- register OLT (CONT)/PON-IF
  - NE-OpS registers the package.
    - initialize or configure the component

- register ONU
  - NE-OpS registers the ONU.
    - configure the path settings such as bandwidth parameters

- modification of settings
- retrieval for settings
- retrieval for various information list:
  - such as installation state, type, vendor, version …

※ delete ONU, PON-IF, OLT, removal
  - reverse procedure of registration
fault management, maintenance and others

- alarm monitoring
  - receive equipment failure alarms and notify operators
- polling for OLTs
  - active checking as assistance for passive monitoring
- alarm status retrieval, alarm log retrieval
- testing, ONU exchange
- remote reset
- NE software update
- NE restore

system administrative functions

- operation terminal administration
- management for buildings of NE installed
Internal functions of NE-OpS

Functions listed before are:
• implemented first as internal functions.
• called from HMI terminals.
• may be similar to general EMS functions. (GE-PON characteristics appear in the management information and function parameters.)

Cooperation with associated systems will improve efficiency of information exchange and process flow.
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Plan for studying the interface

• There is no GE-PON standard Interface.
• ITU-T Q.834.4 provides BPON management interface between EMS and NMS with CORBA IDL definition.

try to modify Q.834.4 and to apply it for GE-PON

• Q.834.1 (06/04): In force
  ATM-PON requirements and managed entities for the network and network element views

• Q.834.3: Pre-published
  A UML description for management interface requirements for broadband Passive Optical Networks

• Q.834.4 (07/03): In force
  A CORBA interface specification for Broadband Passive Optical Networks based on UML interface requirements
•Open interfaces for NMSs with CORBA IDL
  -in reference to Q.834.4, X780, Q.816, OMG Naming Service
  -providing operational APIs
  -virtual NW & NE management view mapped on the interface
  -without direct access to internal objects
•Coarse-grained interface
  -appropriate granularity
•Attached CORBA adapter
•Loose coupling with internal implementation
•Some retrieval functions addition
Service Object and Domain Object

Service Object:
- provides management functions in the EMS.
- implements the IDL interfaces.
- is registered to the Naming Service.

Domain Object:
- corresponds to a managed object.
- is accessed indirectly through a service object.
- is not registered to the Naming Service. Its identifier is determined by the structure of the Naming Graph.
The naming rule was pre-defined and agreed with connecting systems.

```c
typedef string Istring;
struct NameComponent {
    Istring id;
    Istring kind; // --> kind="";
};
typedef sequence <NameComponent> Name;
```
Definition of Naming Graph for Domain Objects

OLT(CONT)

shelf

dotted line

slot

dotted line

package

dotted line

SNI port

PON port

OLT

EquipmentHolder(shelf)

plugInUnitF

physicalPathTPF

undefined

not in use in the current interface APIs

ONT

physicalPathTPF

SubNetworkConnection?

section?

MAC?

LogicalLinkTP?
Definition of the identifier for domain objects

Syntax: ManagedEntityIdType

```
struct ManagedEntityIdType {
    IdType id; // --> enum(none)
    MEIdType mEId;
};
typedef RDNType MEIdType;
typedef sequence<NamingComponentType> RDNType;
struct NamingComponentType {
    string type; // managed entity type
    string id;
};
```

<table>
<thead>
<tr>
<th>type</th>
<th>id</th>
<th>a note about “id”</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLT</td>
<td>OLT</td>
<td>xxx</td>
</tr>
<tr>
<td>EquipmentHolder(shelf)</td>
<td>shelf</td>
<td>01</td>
</tr>
<tr>
<td>EquipmentHolder(slot)</td>
<td>slot</td>
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<td>01</td>
</tr>
<tr>
<td>ONT</td>
<td>ONT</td>
<td>xxx01yyy0101zzz</td>
</tr>
</tbody>
</table>
Interface example(1)

**PON-IF registration**

interface Builder: itut_x780::ManagedObject {

ManagedEntityIdType buildPlugInUnit2 (  
in ManagedEntityIdType nEId,  
in string equipmentCode,  
in ManagedEntityIdType equipmentHolder,  
....  
in ProfileInfoType pluginUnitProfile)  
raises (error1, error2,..... );

Profile

NE specific or service specific parameters are packed in the form of defined structures respectively. Thus method definition itself can be described independently of service and technology.

typedef unsigned short ProfileKindType;

struct ProfileInfoType {
    ProfileKindType profileKind;
    any attributeValueustruct;
};
Interface example(2)

• EQP Alarm

interface AlarmEventHandler {
    void equipmentAlarm(
        in string eventTime,
        in ManagedEntityIdType source,
        in ProbableCauseType probableCause,
        in PerceivedSeverityType perceivedSeverity,
        ...
    ) raises (error1);
}

• This method is implemented on the receiving system. The remote address (object reference) is taught from the Naming Service.

• Originally “equipmentAlarm” is defined in the X.780 Interface “Notifications”. But it has many unused parameters. Then “AlarmEventHandler” was defined instead of using “itut_x780::Notifications”.

The source domain object.

if (cause=“FAN” or “PowerSupply”) then source=”OLT”
(because of coarse-grained model)
Interconnection and transaction

Before Interconnected
- Without failure it is desirable that OpS and NE data are synchronously changed or synchronously unchanged.
- As a recovery procedure for small failure, rollback processing within reasonable degree may be effective.

Transaction is practically regarded as atomic.

After Interconnected
- On the CORBA adapter, a synchronous method invocation is equivalent to the corresponding internal function.
- Atomic transaction is simply extended to an NMS and mutual data can be updated synchronously.
- In this interfaces the transaction service is not used. Then the method itself can not do processes such as commit, abort, rollback.
Interconnection and concurrency

● Before Interconnected

An NE-OpS receives requests from multiple clients and manages multiple NEs.

• Concurrent requests from clients can be ordinarily processed as a general software.
• NE access procedures should be carefully designed using exclusive access control considering the NE’s specifications to avoid conflicting in the NE resources.

● After Interconnected

• On the CORBA adapter, a method invocation is translated and connected to the corresponding internal function.
• Internal concurrent and exclusive control mechanism is also available for CORBA interfaces.
Operation flows on interconnection and related function

• Initial concept:
  All registration operations will be executed from an NMS.

• Actual flow:
  NE-OpS and NMS are used together. A new cooperative function became required to notify NMS of data change.

The event “stateChange” was defined as the trigger to synchronously update the NMS DB.
(Currently the target to notify is one object different from that of alarms.)
Conclusion

- The function of NE-OpS required in order to employ a GE-PON system was considered.
- With Q.834.4 for BPON as a reference, interface for interconnection to external OpS was drawn up.
- From viewpoint below, past experience was helpful to the development of new NE-OpS.

  - A GE-PON OLT is the devices of the same PON type as a existing STM-OLT and a B-OLT.
  - If modus operandi has been similar to the past PON device, the short-term technical acquisition of operators will be expected.
Thank you.