Proposed User Comment Draft

Joint AASHTO / ITE / NEMA Standard Publication TS 9. CORBA – 1998

NATIONAL TRANSPORTATION COMMUNICATIONS FOR ITS PROTOCOL (NTCIP)

Applications Profile – Common Object Request Broker Architecture

(AP-CORBA)

Draft Version 98.01.02 February 14, 1998

Published by

American Association of State Highway and Transportation Officials (AASHTO)
444 North Capital St. N.W., Suite 249
Washington, D. C. 20001

Institute of Transportation Engineers (ITE)
525 School St. S.W., Suite 410
Washington, D. C. 20024-2797

National Electrical Manufacturers Association (NEMA)
1300 N. 17th Street, Suite 1847
Rosslyn, Virginia 22209-3801

[Copyright text that is to appear on title page when sent out as a Recommended Standard.]

[Text that is to appear on second page when sent out as a Recommended Standard.]

Contents

1. Introduction

1.1 OVERVIEW

1.1.1 Purpose

This document identifies protocols supporting the use of the Common Object Request Broker Architecture, CORBA, as a mechanism of information interchange among traffic management and information centers. It is one of two alternative protocols which may be used for center-to-center data interchange. The other is defined in AP-DATEXA, alternatively known as DATEX-ASN, ISO/TC 204/SC, dated 1998-01-19.

1.1.2 Scope

This standard is applicable to communications between any two management subsystems within the Intelligent Transportation Systems (ITS) environment. This standard specifies the requirements for a standard open interface between transportation centers for the specific purpose of interoperability. This standard does not address the needs of center-to-field or field-to-field communications, although, with adequate bandwidth and node processing power, this standard could extend to "smart" controllers. These requirements specify the necessary protocols, services and application interfaces to enable center-to-center communications for small or large-scale enterprises, using the Common Object Request Broker Architecture (CORBA) software. This standard is not meant to support the strict real-time requirements of low-bandwidth field links, nor is it intended for prior-generation, lower-performance processors.

1.1.2 Background

In the early deployment of the Intelligent Transportation Systems (ITS), the need for center to center integration was considered secondary to the center's integration with its own field infrastructure. However, it was just a matter of time before the burgeoning deployment of ITS elevated the need for, not only center to center integration, but center-to-center interoperability in major transportation corridors consisting of multiple Transportation Management Centers (TMC) with large existing field infrastructures. With the designation of four major transportation corridors by the Federal Highway Administration (FHWA), the urgency for corridor-wide integration was confirmed and, along with it, the need for open standards that would make it happen.

At first, the logical starting place for a center-to-center communications protocols standard was the extension of the NTCIP Class C Protocol Specification, which is based upon the ISO (seven-layer) communication stack. It soon became evident that extending the Class C Protocol to handle the multitudinous heterogeneous systems that could typically make up a regional corridor, would be impractical. It would require all layers of the communications stack to be specified and a large number of services would have to be developed on all of the participating systems to ensure inter-operabily. As an alternative, a proposal was made for an object-oriented standard designed especially for distributed systems. The result was a proposal for a Center-to-Center protocol specification based upon the Common Object Request Broker Architecture (CORBA). CORBA would provide a framework upon which could be applied specifications for the particular approaches and service requirements that characterize a multi-center transportation network.

A list of services which it was hoped that a general center-to-center communications protocol might support was developed. Attempts were made to identify how the Common Object Request Broker Architecture would support these service requirements.

Two major concerns were raised by the committee membership. First, would the multi-layer, multi-service software mechanisms of CORBA be efficient enough to permit the transfer of near-real-time data

from center to center? Here near-real-time data is intended to mean data objects whose attributes change in value on the order of once-a-second. Representative data includes traffic signal cycle data and video camera-control information. To be useful at a remote center, such data must have a relatively -constant latency of delay, which must be less than the change interval. An alternative approach using sockets was proposed. However, these abandoned many of the desirable standardization and inter-operability features offered by CORBA.

Second, would not "legacy systems," those completed before or under-development/construction during the time this specification became a standard, be "unfairly" required to grossly alter their architecture and interfaces to comply with this specification, or else be stigmatized as "non-compliant" with the standard and not able to inter-operate even in a limited fashion with other, compliant centers? The alternative approach using sockets was proposed based on the notion that most of the in-production or in-development centers would be using a sockets-based approach and that this would require minimal system modification.

There was much concern that these data exchanges would be developed on an as-needed basis, and that all new applications and new center-to-center interactions would require new development at additional cost. The concern was also expressed that centers requiring only limited data exchange with adjacent centers would be required to implement a complete CORBA ORB to support the specification. Some in the committee deemed this a good thing because it would make the center interoperable in the future. Others felt this was an unrealistic development burden.

The conclusion of the NTCIP Center-to-Center Working Group was to develop two applications layer protocols using lower level communications protocols in general use. One is for the CORBA approach and one for a DATEX-ASN implementation. In accordance with the taxonomy defined by the NTCIP Taxonomy Working Group, the profile for inter-center communication utilizing CORBA ORBs is contained in this document, designated AP-CORBA. The profile for inter-center communication utilizing DATEX and ASN is designated in a document titled "Transport Information and Control Systems--Data Exchange Between Traffic Management and Information Centres--Part 3: DATEX-ASN," (ISO/TC 204/SC Date: 1998-01-19 /WD) and called AP-DATEX-ASN. These documents are subordinate to general center-to-center requirements designated in a document entitled "NTCIP Specification -Center to Center Communications", designated DP-C2C, in development by the NTCIP Center to Center WG.

1.1.4 Acknowledgements

Many people have contributed to the development of this profile. Some of these contributors are: the webmaster of the NTCIP web site; NTCIP Center-to-Center Communications Protocols Working Group committee members, especially Jeff Brummond, Greg Mosley, John Wintermute, and Ken Vaughn, whose prior working draft documents have been shamelessly plagarized; and Bruce Schopp (BS) and Warren Tighe (WT), whose meeting notes provided invaluable information about the thinking and intent of the committee membership and of interested parties not in attendance at working group meetings. The Object Management Group, through the assistance of Mark Lowenstein, and of John Lewis, director of their Transportation Domain Special Interest Group, has been greatly helpful through the provision of CORBA specifications, books and articles, and by providing references to others working in the transportation management domain.

1.2 REFERENCES

For approved revisions, contact:

NTCIP Coordinator
National Electrical Manufacturers Association
1300 N. 17th Street, Suite 1847
Rosslyn, Virginia 22209-3801
Fax: (703) 841-3331

e-mail: ntcip@nema.org

For draft revisions of this document, which are under discussion by the relevant NTCIP Working Group, and recommended revisions of the NTCIP Joint Committee, visit the World-Wide Web at http://www.ntcip.org.

1.2.1 Normative References.

The following documents and base standards provide a more complete understanding of this application profile as described herein.

a. The Common Object Request Broker: Architecture and Specification, Revision 2.1, The Object Management Group, Inc., July 1995, last revised September 1997. (CORBA 2.1).

b. Common Facilities Architecture, Object Management Group, Framingham, Massachusetts, November 1995, last revised June 15, 1997.

c. Common Object Services Specifications, Object Management Group, John Wiley & Sons, 1995, last revised December 2, 1997.

d. National Transportation Communications for ITS Protocol (NTCIP) Application Profile - Data Exchange-ASN.1 (AP-DATEX-ASN), NTCIP Center-to-Center Working Group, Draft Version 97.01.01, December 22, 1997.

e. National Transportation Communications for ITS Protocol (NTCIP) Application Profile - Transport Control Protocol (AP-TCP), NTCIP TBD Working Group, TBD

f. Simple Mail Transfer Protocol, Request for Comment 821, Internet Architecture Board, August 1982

g. MIME (Multipurpose Internet Mail Extensions) Part 1: Mechanisms for Specifying and Describing the Format of Internet Message Bodies, Request for Comment 1521, Internet Architecture Board, September 1993.

h. MIME (Multipurpose Internet Mail Extensions) Part 2: Message Header Extensions for Non-ASCII Text, Request for Comment 1522, Internet Architecture Board, September 1993..

i. File Transfer Protocol, Request for Comment 959, Internet Architecture Board, October 1985.

1.2.2 Informative References

a. AASHTO/ITE/NEMA TS 3.PRO-199x, National Transportation Communications for ITS Protocol (NTCIP) Framework and Classification of Profiles.

b. ISO 7498:1984, Information Processing Systems--Open Systems Interconnection--Basic Reference Model.

c. NEMA NS 1-1995, Guide for Preparation of NEMA Standards Publications.

At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standard listed below.

1.3 DEFINITIONS, ACRONYMS, AND TERMS

AASHTO	American Association of State Highway and Transportation Officials
ASN.1	Abstract Syntax Notation One. A formal syntax-definition language used to define communications messages and data objects
Client	An object or program which accesses a server through one of its interfaces.
Communication Network	a collection of interconnected equipment's that provides a data communications service for devices, often computers attached to the equipments.
CORBA	Common Object Request Broker Architecture—Current Revision is 2.1.
COSS	CORBA Object Service Specifications. OMG Specifications for Services.
Data Link Layer	The level of protocol as defined by ISO that provides service to transfer data between network layer entities, usually in adjacent nodes. The data link layer provides error detection (and may provide error correction) for errors occurring in the physical layer.
Domain	Domain A realm or range of knowledge, often characterized by uniquely defined terms or acronyms.
FTP	File Transfer Protocol. A standard protocol to transfer files from computer to computer on the Internet.
GIOP	General Input-Output Protocol, used as part of the Presentation layer in CORBA middleware.
IDL	Interface Definition Language. A descriptive language used in CORBA to specify the interface through which clients may access servers to obtain access to objects.
IIOP	Internet Inter-ORB Protocol, Application and Presentation software for CORBA. Uses GIOP as the Presentation layer.
IOR	Interoperable Object Reference. Object reference protocol associated with IIOP.
IR	Interface Repository. Standard CORBA Service for storing IDL definitions. Most especially, a national repository or registry, connected to the internet, containing in a database, descriptions for objects and their attributes, including that data attributed to data dictionaries and message catalogs.
ISO	International Organization for Standardization, a voluntary organization consisting of designated standards bodies of participating world nations. By agreement with the IEC, the ISO is primarily involved with standard relating to the software of communications while the IEC is primarily involved with standards relating to the hardware of communications.
ITE	Institute of Transportation Engineers
JAVA	An interpreted computer application-development language which is portable across hardware platforms. The language is designed to support World-Wide Web / Internet applications development.
Layer	A group of services, and functions that is conceptually complete, that is one of a set of hierarchical levels forming a complete domain, and that extends to all system nodes which are compliant with the network architecture.
Level	See Layer. Most commonly used in European Communications Standards
Network	A collection of nodes, domains, clients, servers, communications channels interfaces and applications connected together physically and logically
Network Layer	OSI Model Level 3. Carries out routing of data through a communications network.
NRS	Near-real-time Services. An non-standard addition to the use of CORBA within NTCIP Center-to-Center Compliant Systems to provide timely access to frequently changing data (down to a granulation of about 1 second)

NS	Naming Service. Standard CORBA Service for location of objects by name.
NTCIP	National Transportation Communications for ITS Protocol. An initiative to provide a communications standard that ensures the interoperability and interchangeability of traffic control and Intelligent Transportation Systems (ITS)
Object Reference	Instance of an interface, defined in IDL. A client holding it may use it to access the server which provides the implementation object to obtain access to its attributes.
OMG	Object Management Group. Industrial consortium working to standardize open distributed object-based computing.
ORB	Object Request Broker.
OSF	Open Software Foundation, an organization of major computer manufacturers and software vendors which support the development of standards for interoperability of computer hardware, communications and software systems.
Physical Layer	ISO model Layer 1. Covers the electrical, mechanical and timing aspects of signal transmission over a physical medium of communication.
PICS	Protocol Implementation Conformance Statement
Service	In communications, a series of messages defined between applications level protocols, which, in the aggregate, carry out a single activity understandable to a user of the communications system.
TCP	Transport Control Protocol, an Internet Transport layer protocol using sessions.
TMC	Transportation Management Center, also called Center
TS	Trader Service. Standard CORBA service for locating objects by attributes
WG	Working Group. The NTCIP Center-to-Center working group tasked with developing this standard (or other standards) as a part of the overall NTCIP initiative

.

2. Principles and Framework of NTCIP Profiles

2.1 INTRODUCTION

The CORBA Application Profile is intended to provide an interoperability standard for the Application and Presentation Layers for communications between management subsystems within ITS. Its primary purpose is to define the interaction between ITS applications and CORBA applications supporting ITS interoperability.

A profile defines a combination of base standards and/or other profiles that collectively perform the intended function. The definition of Application Profiles and their functions and responsibilities are defined within clause 2 of AASHTO/ITE/NEMA TS 3.PRO-199x. This profile references proposed and approved ISO standards for the Application and Presentation Layers of the OSI Reference Model. The Session layer is defined as being NULL because the selected Application Layer handles this functionality.

The Transport layer, using TCP, is augmented by applications code defined within CORBA, the Internet Inter-ORB Protocol. Figure 2.1-1:Principle Base Standards Addressed in this Profile, illustrates the layers that are addressed and the principle protocols or standards that are applicable to these layers.

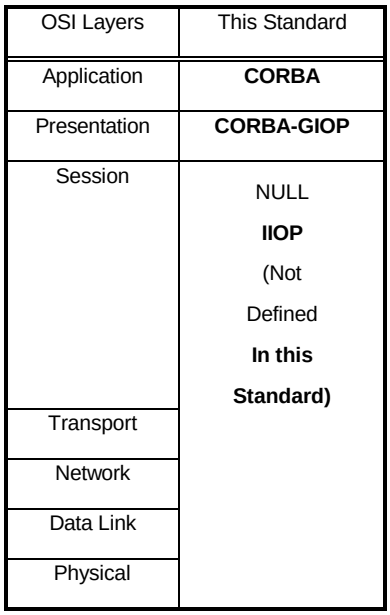

Figure 2.1-1:Principle Base Standards Addressed in this Profile

2.2 OPTIONAL FUNCTIONALITY

Some base standards provide options, anticipating the needs of a variety of applications. The CORBA Specification, Facilities and Services provide a set of application functionality for interoperability of applications running in a computer network. Almost all of this functionality is optional. It may be replaced with equivalent functionality having the same interfaces, or omitted if not useful. However this application profile provides a basis for uniform development, procurement and testing.

2.3 ARCHITECTURAL REQUIREMENTS

There is no specific architecture required, but the underlying assumption is that there is a Client/Server relationship between the connected subsystems as defined in the CORBA Specification and Architecture. This profile is designed to use standard Internet Session, Transport, Network, Data Link and Physical OSI protocol layers, which are defined elsewhere. A general description of the CORBA Architecture and interoperability may be found in "A Discussion of the Object Management Architecture," Object Management Group, January, 1997, available on the OMG web site at **http://www.omg.org**.

3. Requirements

3.1 CONFORMANCE

3.1.1 Optional Features

This profile provides an identification of specific requirements. It also identifies optional requirements, which, under specific circumstances, are required. End-users should assume that all optional features will not be present unless the specific reference to the particular circumstances is made.

A particular implementation may add functions and services, but they must work in conjunction with, and not interfere with, the capabilities stated herein.

3.1.2 Stack Definition

AP-CORBA is one of the Applications Profiles defined for data exchanges between ITS management subsystems. It consists of two (2) of the seven (7) ISO layers as defined in 3.2 through 3.3.

3.1.3 Co-residence

Multiple Application Profiles may reside in the same physical management subsystem. For example, if a management subsystem can meet the requirements for AP-CORBA and AP-DATEX-ASN, then it conforms to each of these AP's.

3.2 APPLICATION LAYER REQUIREMENTS

Applications layer protocols provide communication between processes or applications residing on different computers in a network. CORBA is "middleware", providing a layer of functionality between host-level protocols and end-user applications code. CORBA Specifications are contained in three documents, the CORBA Specification and Architecture, CORBA Common Facilities Specification, and CORBA Common Services Specification. The Application Layer shall conform to the CORBA Specification and Architecture, CORBA Facilities and CORBA Services specifications with no modifications or exceptions.

3.3 PRESENTATION LAYER REQUIREMENTS

3.3.1 Host-to-Host Protocols

The implementation of the General Inter-ORB Protocol on top of the IIOP-TCP transport-level protocol is mandatory for CORBA 2.1 compliance. The Presentation Layer shall conform to Chapter 12 of the CORBA Specification and Architecture, "General Inter-ORB Messaging Protocol", with no modifications or exceptions.

3.3.2 Environment-specific Inter-ORB Protocol

As an option, centers may additionally support the Environment-specific Inter-ORB Protocol (ESIOP) for network-specific needs.

3.3 TRANSPORT LAYER REQUIREMENTS.

The Transport layer shall conform to the TCP transport level protocol as defined in TBD. The Transport layer shall be augmented with the Internet Inter-ORB Protocol (IIOP) as defined in the CORBA Specification. IIOP, Chapter 12, pages 33 and following, with no modifications or exceptions.

3.5 OTHER INTERNET-COMPLIANT PROTOCOLS

In addition to the use of CORBA ORBs, several other applications layer protocols support center inter-operability. Applications protocols to support the exchange of mail from center to center, the Simple Mail Transfer Protocol (SMTP), to support the exchange of data files among centers with compatible data formats, the File Transfer Protocol (FTP).

3.5.1 Mail Transfer Protocols

Compliant centers shall support the Simple Mail Transfer Protocol as defined in Simple Mail Transfer Protocol (RFC 821), and Standard for the Format of ARPA Internet Text Messages (RFC 822).

It is desirable, but not required, that centers also support MIME extensions to STMP as defined in MIME (Multipurpose Internet Mail Extensions) Part 1: Mechanisms for Specifying and Describing the Format of Internet Message Bodies (RFC 1521) and MIME (Multipurpose Internet Mail Extensions) Part 2: Message Header Extensions for Non-ASCII Text (RFC 1522).

3.5.2 File Transfer Protocol

Compliant centers shall support the File Transfer Protocol as defined in File Transfer Protocol (RFC 959).

Annex A

Profile Implementation Conformance Statement Requirement Lists

A1 INTRODUCTION

A2 NOTATION

The following keys are used, in the subsequent conformance lists, to define the functions, parameters, classes, etc. supported for which conformance is claimed.

A2.1 Base Standard and Profile Status Notation Keys

M,m	mandatory
O,	optional
O.<n>	optional, but support of at least one of the group of options labeled by the same numeral <n> is required
U	unambiguous in defining base standard
<index>:	this predicate symbol means that the status following it applies only when the PICS states that one or more of the items is supported.
<index>::	when this group predicate is true then the associated clause should be completed.
I	outside scope
D	deprecated (listed for compatibility with older systems)
-	not applicable
X	excluded (use is prohibited within the context of this profile)

The mandatory "m" requirement level shall indicate that support of the feature is mandatory for all implementations claiming support with this Profile.
The optional "o" " requirement level shall indicate that support of the feature is left to the implementor.
The conditional "c" requirement level shall indicate that support for the item depends on a specified condition. The condition and the resulting support requirements are stated separately.

The mandatory "I" requirement level shall indicate that support for the item is outside the scope of this part of ISP.

A3 PICS REQUIREMENTS LIST

A3.1 Application Layer

A3.1.1 CORBA Specification and Architecture

CORBA Specification and Architecture, exclusive of Chapter 12, 13 (see Presentation Layer Below)

Base Standard						AP-CORBA		
Item	Feature	Direction	Reference /Clause	Client Status	Server Status	Reference /Clause	Client Status	Server Status
1	The Object Model		1-1	M	M		m	m
2	CORBA Architecture		2-1	M	M		m	m

3	OMG IDL Syntax and Semantics		3-1	M	M		m	m
4	Dynamic Invocation Interface		4-1	M	M		m	m
5	ORB Interface		5-1	M	M		m	m
6	Dynamic Skeleton Interface		6-1	M	M		m	m
7	The Interface Repository		7-1	M	M		m	m
8	The Basic Object Adapter		8-1	M	M		m	m
9	Interoperability Overview		9-1	O	O		m	m
10	ORB Interoperability Architecture		10-1	O	O		m	m
11	Building Inter-ORB Bridges		11-1	O	O		o	o
12	Interworking (sic) Architecture		14-1	O	O		o	o
13	Mapping: COM and CORBA		15-1	O	O		o	o
14	Mapping: OLE Automation and CORBA		16-1	O	O		o	o
15	Requirements for a Language Mapping		17-1	M	M		m	m
16	Mapping of OMG IDL to C++		18-1	O.1	O.1		o.1	o.1
17	Mapping of OMG IDL to Smalltalk		19-1	O.1	O.1		o.1	o.1
18	Mapping of OMG IDL to COBOL		20-1	O.1	O.1		o.1	o.1
19	Mapping of OMG IDL to ADA		21-1	O.1	O.1		o.1	o.1
20	Standard OMG IDL Types		A-1	M	M		m	m
21	OMG IDL Tags		B-1	M	M		m	m

A3.1.2 CORBA Facilities

Base Standard						AP-CORBA		
Item	Feature	Direction	Reference /Clause	Client Status	Server Status	Reference /Clause	Client Status	Server Status
1	(All CORBA Facilities)	C -> S		O	O		o	o

A3.1.3 CORBA Services

CORBA Common Object Service Specification. It is assumed that, as regards Security, Event, and Query services, functionality is mandatory, even though it may not be provided through the CORBAServices API.

Base Standard						AP-CORBA		
Item	Feature	Direction	Reference /Clause	Client Status	Server Status	Reference /Clause	Client Status	Server Status
1	General Design Principles		2-1	O	O		m	m
2	Naming Service Specification		3-1	O	O		m	m
3	Event Service Specification		4-1	O	O		m	m
4	Persistent Object Service Specification		5-1	O	O		o	o
5	Life Cycle Service Specification		6-1	O	O		o	o
6	Concurrency Control Service		7-1	O	O		o	o
7	Externalization Service Specification		8-1	O	O		o	o
8	Relationship Service Specification		9-1	O	O		o	o
9	Transaction Service Specification		10-1	O	O		o	o
10	Query Service Specification		11-1	O	O		m	m

11	Licensing Service Specification		12-1	O	O		o	o
12	Property Service		13-1	O	O		o	o
13	Time Service Specification		14-1	O	O		o	o
14	Security Service Specification		15-1	O	O		m	m
15	Security Reference Model		15-12	O	O		m	m
16	Authentication of Principals		15-90	O	O		m	m
17	Credentials		15-94	O	O		o	o
18	Object Reference		15-98	O	O		o	o
19	Security Operations on Current		15-102	O	O		o	o
20	Security Audit		15-107	O	O		m	m
21	Administering Security Policy		15-109	O	O		m	m
22	Use of Interfaces for Access Control		15-109	O	O		o	o
23	Use of Interfaces for Delegation		15-111	O	O		o	o
24	Non-Repudiation		15-113	O	O		m	m
25	Secure Inter-ORB Protocol (SECIOP)		15-174	O	O		o	o
26	Trading Object Service Specification		16-1	O	O		o	m
27	Object Collection Specification		17-1	O	O		o	o

A3.2 Presentation Layer

CORBA Specification and Architecture Chapter 12, 13

Base Standard						AP-CORBA		
Item	Feature	Direction	Reference /Clause	Client Status	Server Status	Reference /Clause	Client Status	Server Status
1	GIOP Common Data Representation		12-3	M	M		m	m
2	GIOP Message Header		12-19	M	M		m	m
3	GIOP Message Types		12-21	M	M		m	m
4	Request Message	C->S	12-21	M	M		m	m
5	Reply Message	S->C	12-24	M	M		m	m
6	Cancel Request	C->S	12-26	M	M		m	m
7	Locate Request	C->S	12-26	M	M		m	m
8	Locate Reply	S->C	12-27	M	M		m	m
9	Close Connection	C->S	12-28	M	M		m	m
10	Message Error	S->C	12-29	M	M		m	m
11	ESIOP		13-1	O	O		o	o
12	DCE-CIOP RPC		13-2	O	O		c::11	c::11
12	Invoke RPC		13-11	O	O		c::11	c::11
13	Locate RPC		13-14	O	O		c::11	c::11
14	DCE-CIOP Data Representation		13-3	O	O		c::11	c::11
15	DCE-CIOP Messages		13-6	O	O		c::11	c::11
16	DCE-CIOP Object Location		13-22	O	O		c::11	c::11

A3.3 Transport Layer (additions via IIOP), CORBA Specification and Architecture, 12-33,36

Base Standard						AP-CORBA		
Item	Feature	Direction	Reference /Clause	Client Status	Server Status	Reference /Clause	Client Status	Server Status
1	Internet Inter-ORB Protocol		12-33	M	M		m	m

2	TCP/IP Connection Usage		12-33	M	M		m	m
3	IIOP IOR Profiles		12-34	M	M		m	m
4	IIOP IOR Profile Components		12-36	M	M		m	m