Practical Experiences of using the OMG’s Extensible Transport Framework (ETF) to Implement QoS Sensitive Custom Transports

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Agenda

1. Background
2. ETF Interfaces
3. Transport Plug-in Case Studies
4. Practical Experiences
5. Conclusions
Objective – to establish a framework for plugging in transports in an ORB with sufficient predictability in order to support DRE systems

WHY – IIOP (GIOP over TCP/IP) enables reliable remote messaging, however TCP/IP introduces unpredictable latencies unsuitable for many real-time systems
Scope

- GIOP messaging and CDR encoding is adequate for real-time systems
- No requirement to specify a alternative messaging protocol to GIOP
- Should provide clear separation on concerns between the messaging layer (GIOP) and the transport layer (e.g. TCP/IP)
- Specifically by defining interfaces to enable ORB core, facility and service layers to be independent of the underlying transport
- Facilitate the development of 3rd party transport solutions
Background

Key Requirements

- Must support an IOR architecture for non TCP transports such that it is possible for a transport author to create a transport plug-in for two different ORBs that enable application interoperability across the transport.
- Clearly identified interfaces and interaction semantics between the ORB and the plugin.
- How an ORB specifies a transport should be specified.
Resulted in:

- Extensible Transport Framework Specification (document reference ptc/04-03-03)
- Which is an OMG final adopted specification
- With submissions or contributions from the following companies:
  - Borland Software Corp.
  - Objective Interface Systems, Inc.
  - VERTEL Corp.

Current Status:
- Undergoing finalization
ETF Interfaces

ETF::Factories
- Local interface
- Provides ‘entry point’ for ORB to use transport
- Plugged into ORB via proprietary mechanism
- Identified by IOP::ProfileId (IIOP etc)

- create_listener(…) : ETF::Listener
- create_connection(…) : ETF::Connection
- demarshal_profile(…)
ETF Interfaces

ETF::Listener

- Local interface
- Endpoint which clients contact when connecting
  - Associated ETF::Profile endpoint (its transport address)
- Encapsulates Connection establishment protocol
  - May be provided by underlying transport (TCP)
  - Otherwise implemented in plugin code (SHMEM)
- ORB may use blocking or non-blocking style
  - ORB thread calls blocking accept() operation
  - ETF thread calls ORB via ETF::Handle callback
ETF Interfaces

ETF::Connection

- Local interface
- Encapsulates semantics of Connection protocol
  - Reliable, ordered, 1-to-1, bi-directional byte stream
- Overloaded interface for client and server side
- Initiated from client-side
  - ORB creates a Connection using Factories
  - ORB calls connect() to establish connection
- Server-Side
  - Listener creates new Connection object in response to incoming request from client.
- Client and server then read/write over Connection
ETF Interfaces

ETF::Profile

- Local interface
- Encapsulates the conversion and matching functions used to store transport specific profile data in an IOR
- Can also be used to locate a “matching” profile read from an IOR
- Holds data related to an address for a transport
- marshal() function creates an ETF::AddressProfile which packages all profile address data into an octet sequence
ETF Interfaces

 ETF::Handle

- Local interface
- Implemented by the ORB
- ORB registers a Handle with ETF
- Enables flexible threading models
- ETF then makes up-calls to Handle when:
  - A new connection has been established
  - Data has arrived on an existing connection
- ORB thus avoids some blocking calls to ETF.
- ORB must still make some blocking calls:
  - connect() & write() still have to be blocking calls
- Only available on the server side
ETF Interfaces

ETF::ConnectionZeroCopy : Connection

- Local interface
- Optional compliance point within the standard
- Supports the notion of a “zero copy” data transfer into the transport layer
- Provides operations to write and read zero copy compatible buffers to and from the transport:
  - void write_zc(inoutBufferList data, …)
  - void read_zc(inoutBufferList data, …)

ETF::BufferList is a local interface that provides operations that manage the allocation of a buffer compatible with the zero copy transport mechanism
ETF Connection Establishment

Client

3: create_connection()
4: connect()

Server

1: create_listener()
2: listen()

Factories

Connection

IOR

P

Connection

Listener

Factories
ETF::Listener encapsulates a listening socket
ETF::Connection encapsulates a connected socket
ETF::Profile encapsulates an endpoint specified by host & port
Hides details of sockets API
Implements timeouts with:
- non-blocking sockets
- select()/poll() calls
ETF::Listener creates & manages shared memory segment
ETF::Listener allocates a control block at start
ETF::Profile encapsulates an endpoint specified by a file name
ETF::Connections get allocated a control block each
Remainder of shared memory segment used for transfer buffer – shared by connections
Coordination by:
  - POSIX : Semaphores
  - System V : Message Queue
Benefits:

- PrismTech have a single unified transport plugin API underneath our RTE ORBs (e*ORB SDR C and C++ Editions)
- Both ORBs share the same pluggable transport layer code implemented once in C
- Allows us to write a transport plug-in once in C and plug into either ORB without excessive porting
- C++ based transport plugins can be also be plugged into the ORBs – however the C ORB has no way of handle any exceptions thrown by transport written in C++
- The new ETF transport plugin interfaces are an improvement over the original proprietary interfaces – simpler abstraction, easier to document and explain to end users
Experiences

Issues:

- Confuses the boundaries between transport (e.g. TCP), the messaging layer (e.g. GIOP) and the protocol (e.g. IIOP)
  - The spec states "separates the message layer (GIOP) from the Extensible Transport Framework"—but it doesn't

- ETF::Profile includes a supported GIOP version attribute should be protocol version if required (e.g. IIOP::Version)

- ETF::Profile::marshal() operation assumes CDR

- ETF::Factories::demarshal_profile() operation assumes CDR
Issues:

The spec states "a Factories object needs to have an identifier so that the ORB can select the correct transport type"—but it doesn't.

- An ETF::Factories object is identified by an IOP::ProfileId — much more than "transport type"

- An IOP::ProfileId identifies a protocol, which implies a specific message layer and tagged profile encoding etc

- Cannot use a transport plugin with different message layers to form different protocols.
Experiences

Issues:

Issue 7594:ETF::Profile::marshal() and ETF::Factories::demarshal_profile() are unworkable:

- The ETF plugin has no access to IOP::TaggedComponents in the full IOP::TaggedProfile. When marshaling a tagged profile, the ETF plugin may want to add tagged components, and when unmarshaling it may want to read them.

- When marshaling a full tagged profile, the ETF marshals part of it (ETF::AddressProfile), and then the ORB marshals the rest (IOP::ObjectKey & IOP::TaggedComponents). For IIOP, at least, these two parts must form a single encapsulation.

- The responsibility for encoding and decoding a full tagged profile is split between the ORB and ETF. The result is that neither party has access to all the information necessary.
Experiences

Issues:

ETF::Handle serves two distinct roles:
1. connection establishment
2. message arrival

It would be better to have two separate handle interfaces to encapsulate the different behaviour, this would enable:

- call-backs and blocking for different areas e.g. call-backs for connection establishment and blocking calls for data transfer

Cannot use ETF::Handle interface on client side connections – when de-multiplexing replies from a shared connection, the ORB must use a dedicated I/O thread to do blocking/polling calls on the connection
Conclusions

- Provides a standard set interfaces by which a ORB transport plugin can implemented
- Currently specified interfaces are not enough to successfully implement a complete transport plugin, additional ORB level implementation is required per plugin
- More useful at present to an ORB vendor, or an end user, rather than a third party transport author
- Transport plugin cannot be written once and plugged into two ORBs from different vendors
- Separation between message, protocol and transport layers is not enforced cleanly enough
- Changes required during specification finalization to address fundamental issues