ORTE – Open Real-Time Ethernet

Petr Smolik
CTU

Pavel Pisa
CTU

Michal Sojka
CTU

Zdenek Sebek
CTU

Zdenek Hanzalek
CTU

ORTE – Open Real-Time Ethernet

by Petr Smolik, Pavel Pisa, Michal Sojka, Zdenek Sebek, and Zdenek Hanzalek

Published August 2012

Table of Contents

List of Figures

Chapter 1. ORTE Description

1.1. Introduction

The Open Real-Time Ethernet (ORTE) is open source implementation of RTPS communication protocol. RTPS is new application layer protocol targeted to real-time communication area, which is build on the top of standard UDP stack. Since there are many TCP/IP stack implementations under many operating systems and RTPS protocol does not have any other special HW/SW requirements, it should be easily ported to many HW/SW target platforms. Because it uses only UDP protocol, it retains control of timing and reliability.

RTPS protocol is being to submit to IETF as an informational RFC and has been adopted by the IDA group.

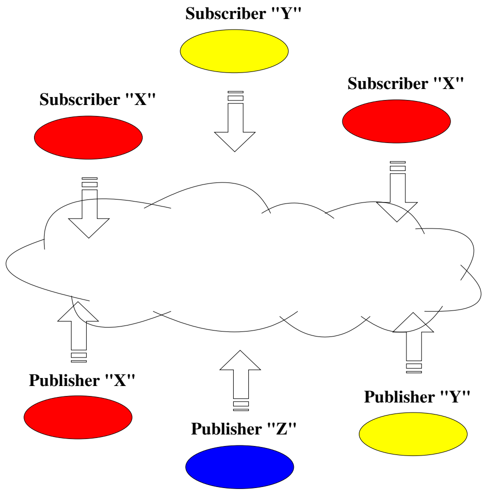
1.2. The Publish-Subscribe Architecture

The publish-subscribe architecture is designed to simplify one-to-many data-distribution requirements. In this model, an application “publishes” data and “subscribes” to data. Publishers and subscribers are decoupled from each other too. That is:

- Publishers simply send data anonymously, they do not need any knowledge of the number or network location of subscribers.
- Subscribers simply receive data anonymously, they do not need any knowledge of the number or network location of the publisher.

An application can be a publisher, subscriber, or both a publisher and a subscriber.

Figure 1-1. Publish-Subscribe Architecture



Publish-subscribe supports anonymous, event-driven transfer between many nodes. The developer simply writes the application to send or receive the data.

Publish-subscribe architectures are best-suited to distributed applications with complex data flows. The primary advantages of publish-subscribe to applications developers are:

- Publish-subscribe applications are modular and scalable. The data flow is easy to manage regardless of the number of publishers and subscribers.
- The application subscribes to the data by name rather than to a specific publisher or publisher location. It can thus accommodate configuration changes without disrupting the data flow.
- Redundant publishers and subscribers can be supported, allowing programs to be replicated (e.g. multiple control stations) and moved transparently.
- Publish-subscribe is much more efficient, especially over client-server, with bandwidth utilization.

Publish-subscribe architectures are not good at sporadic request/response traffic, such as file transfers. However, this architecture offers practical advantages for applications with repetitive, time-critical data flows.

1.2.1. The Publish-Subscribe Model

Publish-subscribe (PS) data distribution is gaining popularity in many distributed applications, such as financial communications, command and control systems. PS popularity can be attributed to the dramatically reduced system development, deployment and maintenance effort and the performance advantages for applications with one-to-many and many-to-many data flows.

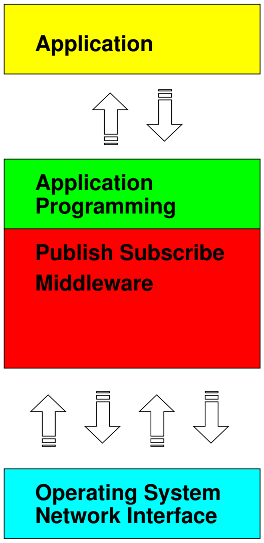
Several main features characterize all publish-subscribe architectures:

Distinct declaration and delivery. Communications occur in three simple steps:

- Publisher declares intent to publish a publication.
- Subscriber declares interest in a publication.
- Publisher sends a publication issue.

The publish-subscribe services are typically made available to applications through middleware that sits on top of the operating system s network interface and presents an application programming interface.

Figure 1-2. Generic Publish-Subscribe Architecture


Application
Application Programming
Publish Subscribe Middleware
Operating System Network Interface

Publish-subscribe is typically implemented through middleware that sits on top of the operating system s network interface. The middleware presents a publishsubscribe API so that applications make just a few simple calls to send and receive publications. The middleware performs the many and complex network functions that physically distribute the data.

The middleware handles three basic programming chores:

- Maintain the database that maps publishers to subscribers resulting in logical data channels for each publication between publishers and subscribers.
- Serialize (also called marshal) and deserialize (demarshal) the data on its way to and from the network to reconcile publisher and subscriber platform differences.
- Deliver the data when it is published.

1.2.2. Publish-Subscribe in Real Time

Publish-subscribe offers some clear advantages for real-time applications:

- Because it is very efficient in both bandwidth and latency for periodic data exchange, PS offers the best transport for distributing data quickly.
- Because it provides many-to-many connectivity, PS is ideal for applications in which publishers and subscribers are added and removed dynamically.

Real-time applications require more functionality than what is provided by desktop and Internet publish-subscribe semantics. For instance, real-time applications often require:

- **Delivery timing control:** Real-time subscribers are concerned with timing; for example, when the data is delivered and how long it remains valid.
- **Reliability control:** Reliable delivery conflicts with deterministic timing. Each subscriber typically requires the ability to specify its own reliability characteristics.
- **Request-reply semantics:** Complex real-time applications often have one-time requests for actions or data. These do not fit well into the PS semantics.
- **Flexible delivery bandwidth:** Typical real-time applications include both real-time and non-realtime subscribers. Each subscriber s bandwidth requirements - even for the same publication - can be different.
- **Fault tolerance:** Real-time applications often require “hot standby” publishers and/or subscribers.
- **Thread priority awareness:** Real-time communications often must work without affecting publisher or subscriber threads.
- **Robustness:** The communications layer should not introduce any single-node points-of-failure to the application.
- **Efficiency:** Real-time systems require efficient data collection and delivery. Only minimal delays should be introduced into the critical data-transfer path.

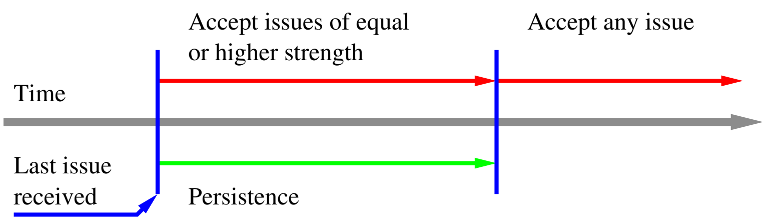
1.3. The Real-Time Publish-Subscribe Model

The Real-Time Publish-Subscribe (RTPS) communications model was developed to address these limitations of PS. RTPS adds publication and subscription timing parameters and properties so the developer can control the different types of data flows and achieve their application s performance and reliability goals.

1.3.1. Publication Parameters

Each publication is characterized by four parameters: topic, type, strength and persistence. The topic is the label that identifies each data flow. The type describes the data format. The strength indicates a publisher s weight relative to other publishers of the same topic. The persistence indicates how long each publication issue is valid. Next figure illustrates how a subscriber arbitrates among publications using the strength and persistence properties.

Figure 1-3. Publication Arbitration



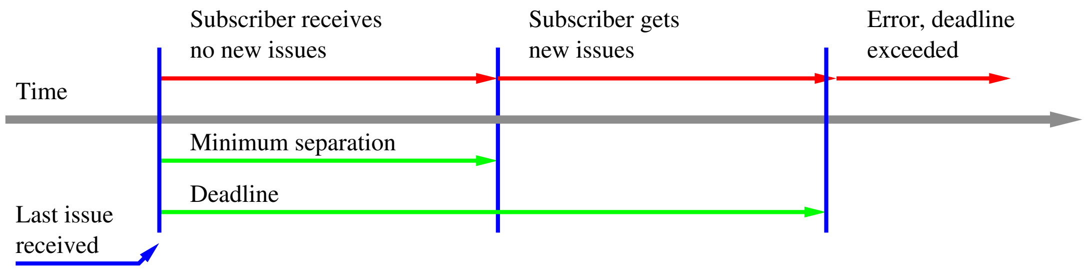
Fault tolerant applications use redundant publishers sending publications with the same topic to ensure continuous operation. Subscribers arbitrate among the publications on an issue-by-issue basis based on the strength and persistence of each issue.

When there are multiple publishers sending the same publication, the subscriber accepts the issue if its strength is greater than the last-received issue or if the last issue s persistence has expired. Typically, a publisher that sends issues with a period of length T will set its persistence to some time Tp where Tp > T. Thus, while the strongest publisher is functional, its issues will take precedence over publication issues of lesser strength. Should the strongest publisher stop sending issues (willingly or due to a failure), other publisher(s) sending issues for the same publication will take over after Tp elapses. This mechanism establishes an inherently robust, quasi-stateless communications channel between the then-strongest publisher of a publication and all its subscribers.

1.3.2. Subscription Paramters

Subscriptions are identified by four parameters: topic, type, minimum separation and deadline. The topic the label that identifies the data flow, and type describes the data format (same as the publication properties). Minimum separation defines a period during which no new issues are accepted for that subscription. The deadline specifies how long the subscriber is willing to wait for the next issue. Next figure illustrates the use of these parameters.

Figure 1-4. Subscription Issue Separation



Once the subscriber has received an issue, it will not receive another issue for at least the minimum separation time. If a new issue does not arrive by the deadline, the application is notified.

The minimum separation protects a slow subscriber against publishers that are publishing too fast. The deadline provides a guaranteed wait time that can be used to take appropriate action in case of communication delays.

1.3.3. Reliability and Time-Determinism

Publish-subscribe can support a variety of message delivery reliability models, not all of which are suitable to real-time applications. The RTPS reliability model recognizes that the optimal balance between time determinism and data-delivery reliability varies between real-time applications, and often among different subscriptions within the same application. For example, signal subscribers will want only the most up-to-date issues and will not care about missed issues. Command subscribers, on the other hand, must get every issue in sequence. Therefore, RTPS provides a mechanism for the application to customize the determinism versus reliability trade-off on a per subscription basis.

The RTPS determinism vs. reliability model is subscriber-driven. Publishers simply send publication issues. However, to provide message delivery reliability, publishers must be prepared to resend missed issues to subscriptions that require reliable delivery.

The RTPS reliability model uses publication buffers publisher and subscriber and retries to ensure that subscribers who need each issue receive them in the proper sequence. In addition, the publisher applies sequence number to each publication issue.

The publisher uses the publication buffer to store history of the most recently sent issues. The subscriber uses its publication buffer to cache the most recently received issues. The subscriber acknowledges issues received in order and sends a request for the missing issue when the most recent issue s sequence number out of order. The publisher responds by sending the missed update again.

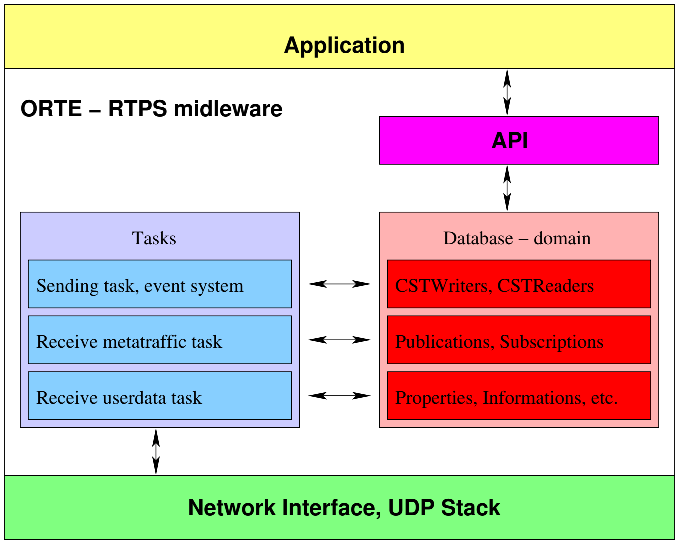
Publishers remove an issue from their history buffers in two cases: the issue has been acknowledged by all reliable subscribers or the publisher overflows the history buffer space. Flow control can be implemented by setting high and low watermarks for the buffer. These publication-specific parameters let the publisher balance the subscribers need for issues against its need to maintain a set publication rate.

Chapter 2. ORTE Internals

ORTE is network middleware for distributed, real-time application development that uses the real-time, publish-subscribe model. The middleware is available for a variety of platforms including RTAI, RTLinux, Windows, and a several versions of Unix. The compilation system is mainly based on autoconf.

ORTE is middleware composed of a database, and tasks. On the top of ORTE architecture is application interface (API). By using API users should write self application. The tasks perform all of the message addressing serialization/deserialization, and transporting. The ORTE components are shown in Figure 2-1

Figure 2-1. ORTE Architecture



The RTPS protocol defines two kinds of Applications:

- **Manager:** The manager is a special Application that helps applications automatically discover each other on the Network.
- **ManagedApplication:** A ManagedApplication is an Application that is managed by one or more Managers. Every ManagedApplication is managed by at least one Manager.

The manager is mostly designed like separate application. In RTPS architecture is able to create application which contains manager and managedapplication, but for easy managing is better split both. The ORTE contains a separate instance of manager located in directory `orte/manager`.

The manager is composed from five kinds of objects:

- **WriterApplicationSelf:** through which the Manager provides information about its own parameters to Managers on other nodes.
- **ReaderManagers:** CSTReader through which the Manager obtains information on the state of all other Managers on the Network.
- **ReaderApplications:** CSTReader which is used for the registration of local and remote managedApplications.
- **WriterManagers:** CSTWriter through which the Manager will send the state of all Managers in the Network to all its managees.
- **WriterApplications:** CSTWriter through which the Manager will send information about its managees to other Managers in the Network.

A Manager that discovers a new ManagedApplication through its readerApplications must decide whether it must manage this ManagedApplication or not. For this purpose, the attribute managerKeyList of the Application is used. If one of the ManagedApplication's keys (in the attribute managerKeyList) is equal to one of the Manager's keys, the Manager accepts the Application as a managee. If none of the keys are equal, the managed application is ignored. At the end of this process all Managers have discovered their managees and the ManagedApplications know all Managers in the Network.

The managedApplication is composed from seven kinds of objects:

- **WriterApplicationSelf:** a CSTWriter through which the ManagedApplication registers itself with the local Manager.
- **ReaderApplications:** a CSTReader through which the ManagedApplication receives information about another ManagedApplications in the network.
- **ReaderManagers:** a CSTReader through which the ManagedApplication receives information about Managers.
- **WriterPublications:** CSTWriter through which the Manager will send the state of all Managers in the Network to all its managees.
- **ReaderPublications:** a Reader through which the Publication receives information about Subscriptions.
- **WriterSubscriptions:** a Writer that provides information about Subscription to Publications.
- **ReaderSubscriptions:** a Reader that receives issues from one or more instances of Publication, using the publish-subscribe service.

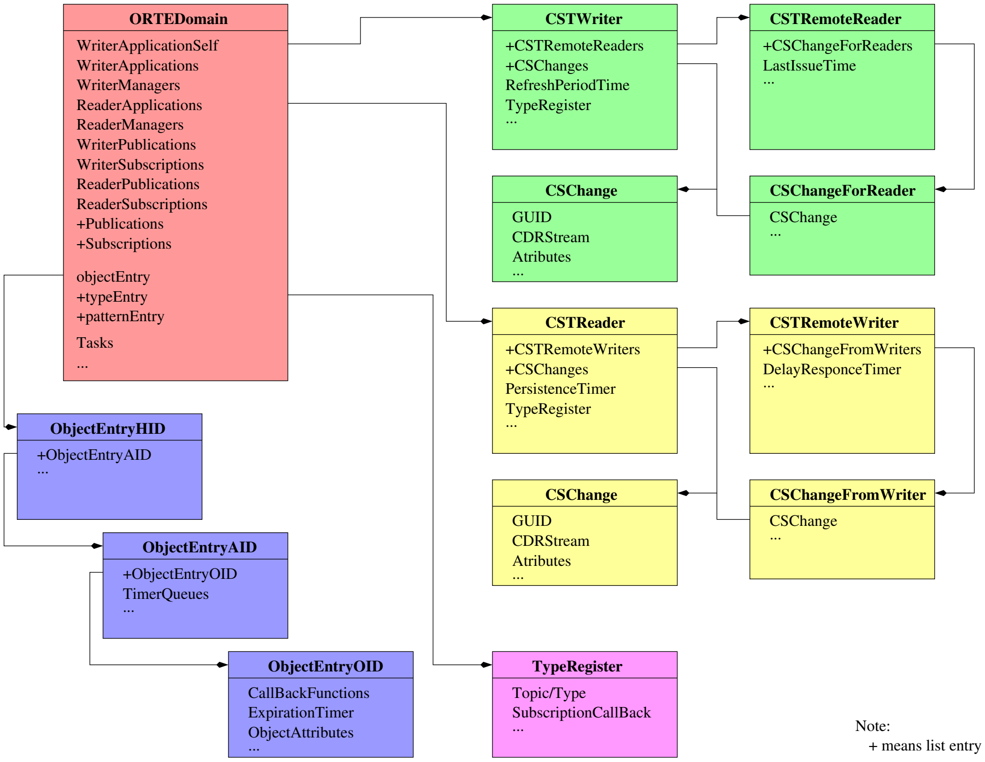
The ManagedApplication has a special CSTWriter writerApplicationSelf. The Composite State (CS) of the ManagedApplication's writerApplicationSelf object contains only one NetworkObject - the application itself. The writerApplicationSelf of the ManagedApplication must be configured to announce its presence repeatedly and does not request nor expect acknowledgments.

The ManagedApplications now use the CST Protocol between the writerApplications of the Managers and the readerApplications of the ManagedApplications in order to discover other ManagedApplications in the Network. Every ManagedApplication has two special CSTWriters, writerPublications and writerSubscriptions, and two special CSTReaders, readerPublications and readerSubscriptions.

Once ManagedApplications have discovered each other, they use the standard CST protocol through these special CSTReaders and CSTWriter to transfer the attributes of all Publications and Subscriptions in the Network.

The ORTE stores all data in local database per application. There isn't central store where are data saved. If an application comes into communication, than will be created local mirror of all applications parameters. Parts of internal structures are shown in Figure 2-2.

Figure 2-2. ORTE Internal Attributes



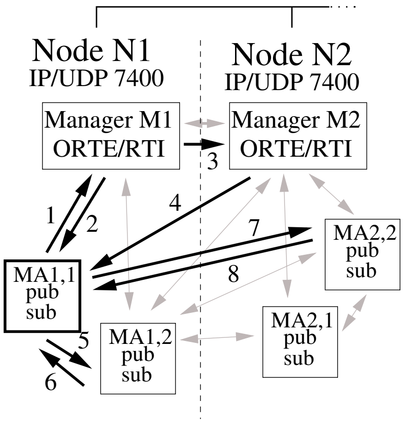
Following example shows communication between two nodes (N1, N2). There are applications running on each node - MA1.2 on node N1 and MA2.1, MA2.2 on node N2. Each node has it own manager (M1, M2). The example shows, what's happen when a new application comes into communication (MA1.1).

1. MA1.1 introduces itself to local manager M1
2. M1 sends back list of remote managers Mx and other local applications MA1.x
3. MA1.1 is introduced to all Mx by M1

4. All remote MAs are reported now to M1.1
5. MA1.1 is queried for self services (publishers and subscriberes) from others MAx.
6. MA1.1 asks for services to others MAx.
7. All MAs know information about others.

The corresponding publishers and subscribers with matching Topic and Type are connected and starts their data communication.

Figure 2-3. RTPS Communication among Network Objects



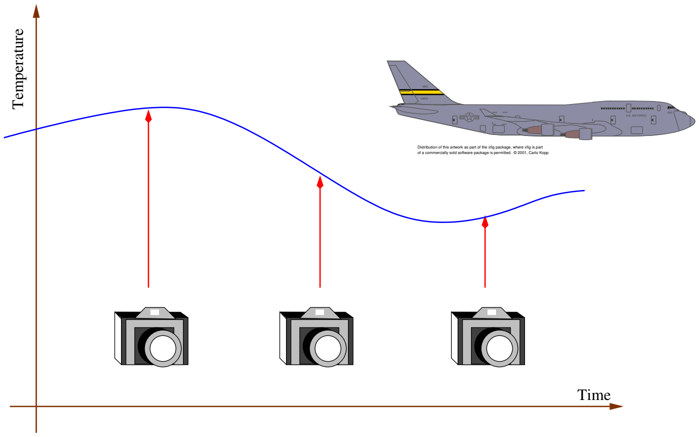
Chapter 3. ORTE Examples

This chapter expect that you are familiar with RTPS communication architecture described in Chapter 1.

Publications can offer multiple reliability policies ranging from best-efforts to strict (blocking) reliability. Subscription can request multiple policies of desired reliability and specify the relative precedence of each policy. Publications will automatically select among the highest precedence requested policy that is offered by the publication.

- **BestEffort:** This reliability policy is suitable for data that are sending with a period. There are no message resending when a message is lost. On other hand, this policy offer maximal predictable behaviour. For instance, consider a publication which send data from a sensor (pressure, temperature, ...).

Figure 3-1. Periodic Snapshots of a BestEffort Publisher


Temperature
AMC
40602
U.S. AIR FORCE
602
Distribution of this artwork as part of the xfig package, where xfig is part of a commercially sold software package is permitted. © 2001, Carlo Kopp
Time

- **StrictReliable:** The ORTE supports the reliable delivery of issues. This kind of communication is used where a publication want to be sure that all data will be delivered to subscriptions. For instance, consider a publication which send commands.

  Command data flow requires that each instruction in the sequence is delivered reliably once and only once. Commands are often not time critical.

3.1. BestEffort Communication

Before creating a Publication or Subscription is necessary to create a domain by using function *`ORTEDomainAppCreate`*. The code should looks like:

```
int main(int argc, char *argv[])
{
  ORTEDomain *d = NULL;
  ORTEBoolean suspended= ORTE_FALSE;

  ORTEInit();

  d = ORTEDomainAppCreate(ORTE_DEFAUL_DOMAIN, NULL, NULL, suspended);
  if (!d)
  {
    printf("ORTEDomainAppCreate failed\n");
    return -1;
  }
}
```

The ORTEDomainAppCreate allocates and initializes resources that are needed for communication. The parameter *suspended* says if ORTEDomain takes suspend communicating threads. In positive case you have to start threads manually by using *ORTEDomainStart*.

Next step in creation of a application is registration serialization and deserialization routines for the specific type. You can't specify this functions, but the incoming data will be only copied to output buffer.

```
ORTETypeRegisterAdd(d, "HelloMsg", NULL, NULL, 64);
```

To create a publication in specific domain use the function ORTEPublicationCreate.

```
char instance2send[64];
NtpTime persistence, delay;

NTPTIME_BUILD(persistence, 3);  /* this issue is valid for 3 seconds */
NTPTIME_DELAY(delay, 1);        /* a callback function will be called every 1 second */
p = ORTEPublicationCreate( d,
                         "Example HelloMsg",
                         "HelloMsg",
                         &instance2Send,
                         &persistence,
                         1,
                         sendCallBack,
                         NULL,
                         &delay);
```

The callback function will be then called when a new issue from publisher has to be sent. It's the case when you specify callback routine in *ORTEPublicationCreate*. When there isn't a routine you have to send data manually by call function *ORTEPublicationSend*. This option is useful for sending periodic data.

```
void sendCallBack(const ORTESendInfo *info, void *vinstance, void *sendCallBackParam)
{
  char *instance = (char *) vinstance;
  switch (info->status)
  {
    case NEED_DATA:
      printf("Sending publication, count %d\n", counter);
      sprintf(instance, "Hello world (%d)", counter++);
      break;

    case CQL:  //criticalQueueLevel has been reached
      break;
  }
}
```

Subscribing application needs to create a subscription with publication's Topic and TypeName. A callback function will be then called when a new issue from publisher will be received.

```
ORTESubscription *s;
NtpTime deadline, minimumSeparation;

NTPTIME_BUILD(deadline, 20);
NTPTIME_BUILD(minimumSeparation, 0);
p = ORTESubscriptionCreate( d,
                           IMMEDIATE,
                           BEST_EFFORTS,
                           "Example HelloMsg",
                           "HelloMsg",
                           &instance2Recv,
                           &deadline,
                           &minimumSeparation,
                           recvCallBack,
                           NULL);
```

The callback function is shown in the following example:

```
void recvCallBack(const ORTERecvInfo *info, void *vinstance, void *recvCallBackParam)
{
  char *instance = (char *) vinstance;
  switch (info->status)
  {
    case NEW_DATA:
      printf("%s\n", instance);
      break;

    case DEADLINE:  //deadline occurred
      break;
  }
}
```

Similarly examples are located in ORTE subdirectory `orte/examples/hello`. There are demonstrating programs how to create an application which will publish some data and another application, which will subscribe to this publication.

3.2. Reliable communication

The reliable communication is used especially in situations where we need guarantee data delivery. The ORTE supports the inorder delivery of issues with built-in retry mechanism

The creation of reliable communication starts like besteffort communication. Difference is in creation a subscription. Third parameter is just only changed to STRICT_RELIABLE.

```
ORTESubscription *s;
NtpTime deadline, minimumSeparation;

NTPTIME_BUILD(deadline, 20);
NTPTIME_BUILD(minimumSeparation, 0);
p = ORTESubscriptionCreate( d,
                           IMMEDIATE,
                           STRICT_RELIABLE,
                           "Example HelloMsg",
                           "HelloMsg",
                           &instance2Recv,
                           &deadline,
                           &minimumSeparation,
                           recvCallBack,
                           NULL);
```

Note:

Strict reliable subscription must set minimumSeparation to zero! The middleware can't guarantee that the data will be delivered on first attempt (retry mechanism).

Sending of a data is blocking operation. It's strongly recommended to setup sending queue to higher value. Default value is 1.

```
ORTEPublProp *pp;

ORTEPublicationPropertiesGet(publisher,pp);
pp->sendQueueSize=10;
pp->criticalQueueLevel=8;
ORTEPublicationPropertiesSet(publisher,pp);
```

An example of reliable communication is in ORTE subdirectory `orte/examples/reliable`. There are located a strictreliable subscription and publication.

3.3. Serialization/Deserialization

Actually the ORTE doesn't support any automatic creation of serialization/deserializaction routines. This routines have to be designed manually by the user. In next is shown, how should looks both for the structure BoxType.

```
typedef struct BoxType {
    int32_t  color;
    int32_t  shape;
} BoxType;

void
BoxTypeSerialize(CDR_Codec *cdrCodec, void *instance) {
  BoxType  *boxType=(BoxType*)instance;

  CDR_put_long(cdrCodec,boxType->color);
  CDR_put_long(cdrCodec,boxType->shape);
}

void
BoxTypeDeserialize(CDR_Codec *cdrCodec, void *instance) {
  BoxType  *boxType=(BoxType*)instance;

  CDR_get_long(cdrCodec,&boxType->color);
  CDR_get_long(cdrCodec,&boxType->shape);
}
```

When we have written a serialization/deserialization routine we need to register this routines to midleware by function `ORTETypeRegisterAdd`

```
   ORTETypeRegisterAdd(
                domain,
                "BoxType",
                BoxTypeSerialize,
                BoxTypeDeserialize,
                sizeof(BoxType));
```

The registration must be called before creation a publication or subscription. Normally is `ORTETypeRegisterAdd` called immediately after creation of a domain (`ORTEDomainCreate`).

All of codes are part of the Shapedemo located in subdirectory `orte/contrib/shape`.

Chapter 4. ORTE Tests

There were not any serious tests performed yet. Current version has been intensively tested against reference implementation of the protocol. Results of these test indicate that ORTE is fully interoperable with implementation provided by another vendor.

Chapter 5. ORTE Usage Information

5.1. Installation and Setup

In this chapter is described basic steps how to makes installation and setup process of the ORTE. The process includes next steps:

1. Downloading the ORTE distribution
2. Compilation
3. Installing the ORTE library and utilities
4. Testing the installation

Note:

On windows systems we are recommend to use Mingw or Cygwin systems. The ORTE support also MSVC compilation, but this kind of installation is not described here.

5.1.1. Downloading

ORTE can be obtained from its web site (http://orte.sf.net/).

The development version of ORTE can be cloned from a Git repository with the following command.

```
   git clone git://orte.git.sourceforge.net/gitroot/orte/orte
```

Attention, this is developing version and may not be stable!

5.1.2. Compilation

Before the compilation process is necessary to prepare the source. Create a new directory for ORTE distribution. We will assume name of this directory `/orte` for Linux case. Copy or move downloaded ORTE sources to `/orte` (assume the name of sources `orte-0.2.3.tar.gz`). Untar and unzip this files by using next commands:

```
gunzip orte-0.2.3.tar.gz
tar xvf orte-0.2.3.tar
```

Now is the source prepared for compilation. Infrastructure of the ORTE is designed to support GNU make (needs version 3.81) as well as autoconf compilation. In next we will continue with description of autoconf compilation, which is more general. The compilation can follows with commands:

```
mkdir build
cd build
../configure
make
```

This is the case of outside autoconf compilation. In directory `build` are all changes made over ORTE project. The source can be easy move to original state be removing of directory `build`.

5.1.3. Installing

The result of compilation process are binary programs and ORTE library. For the next developing is necessary to install this result. It can be easy done be typing:

```
make install
```

All developing support is transferred into directories with direct access of design tools.

name	target path
ortemanager, orteping, ortespy	`/usr/local/bin`
library	`/usr/local/lib`
include	`/usr/local/include`

The installation prefix `/usr/local/` can be changed during configuration. Use command **../configure --help** for check more autoconf options.

5.1.4. Testing the Installation

To check of correct installation of ORTE open three shells.

1. In first shell type

   ```
   ortemanager
   ```

2. In second shell type

   ```
   orteping -s
   ```

   This command will invoked creation of a subscription. You should see:

```
deadline occurred
deadline occurred
...
```

3. In third shell type

   ```
   orteping -p
   ```

   This command will invoked creation of a publication. You should see:

   ```
   sent issue 1
   sent issue 2
   sent issue 3
   sent issue 4
   ...
   ```

   If the ORTE installation is properly, you will see incoming messages in second shell (**orteping -s**).

   ```
   received fresh issue 1
   received fresh issue 2
   received fresh issue 3
   received fresh issue 4
   ...
   ```

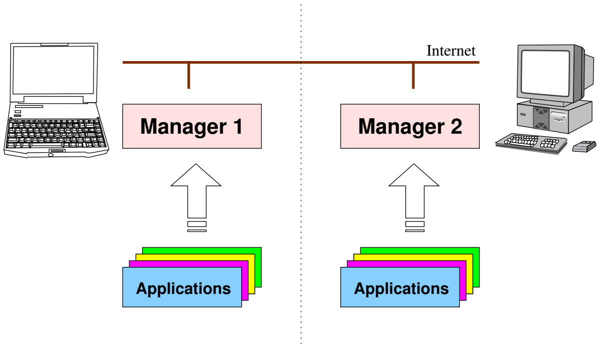
   It’s sign, that communication is working correctly.

5.2. The ORTE Manager

A manager is special application that helps applications automatically discover each other on the Network. Each time an object is created or destroyed, the manager propagate new information to the objects that are internally registered.

Every application precipitate in communication is managed by least one manager. The manager should be designed like separated application as well as part of designed application.

Figure 5-1. Position of Managers in RTPS communication



The ORTE provides one instance of a manager. Name of this utility is `ortemanager` and is located in directory `orte/ortemanager`. Normally is necessary to start `ortemanager` manually or use a script on UNIX systems. For Mandrake and Red-hat distribution is this script created in subdirectory `rc`. Windows users can install `ortemanager` like service by using option */install_service*.

Note:

Don't forget to run a manager (ortemanager) on each RTPS participate node. During live of applications is necessary to be running this manager.

5.2.1. Example of Usage ortemanager

Each manager has to know where are other managers in the network. Their IP addresses are therefore specified as IPAddressX parameters of ortemanager. All managers participate in one kind of communication use the same domain number. The domain number is transferred to port number by equation defined in RTPS specification (normally domain 0 is transferred to 7400 port).

Let's want to distribute the RTPS communication of nodes with IP addresses 192.168.0.2 and 192.168.0.3. Private IP address is 192.168.0.1. The ortemanager can be execute with parameters:

```
ortemanager -p 192.168.0.2:192.168.0.3
```

To communicate in different domain use (parameter -d):

```
ortemanager -d 1 -p 192.168.0.2:192.168.0.3
```

Very nice feature of ortemanager is use event system to inform of creation/destruction objects (parameter -e).

```
ortemanager -e -p 192.168.0.2:192.168.0.3
```

Now, you can see messages:

```
[smolik@localhost smolik]$ortemanager -e -p 192.168.0.2:192.168.0.3
manager 0xc0a80001-0x123402 was accepted
application 0xc0a80002-0x800301 was accepted
application 0xc0a80002-0x800501 was accepted
application 0xc0a80002-0x800501 was deleted
manager 0xc0a80001-0x123402 was deleted
```

ortemanager

Name

`ortemanager` — the utility for discovery others applications and managers on the network

Synopsis

ortemanager [`-d` *`domain`*] [`-p` *`ip addresses`*] [`-k` *`ip addresses`*] [`-R` *`refresh`*] [`-P` *`purge`*] [`-D`] [`-E` *`expiration`*] [`-e`] [`-v` *`verbosity`*] [`-l` *`filename`*] [`-V`] [`-h`]

Description

Main purpose of the utility **ortemanager** is debug and test ORTE communication.

OPTIONS

`-d --domain`

The number of working ORTE domain. Default is 0.

`-p --peers`

The IP addresses parsipiates in RTPS communication. See Section 5.2 for example of usage.

`-R --refresh`

The refresh time in manager. Default 60 seconds.

`-P --purge`

The searching time in local database for finding expired application. Default 60 seconds.

`-E --expiration`

Expiration time in other applications.

`-m --minimumSeparation`

The minimum time between two issues.

`-v --verbosity`

Set verbosity level.

`-l --logfile`

All debug messages can be redirect into specific file.

`-V --version`

Print the version of **ortemanager**.

`-h --help`

Print usage screen.

5.3. Simple Utilities

The simple utilities can be found in the `orte/examples` subdirectory of the ORTE source subtree. These utilities are useful for testing and monitoring RTPS communication.

The utilities provided directly by ORTE are:

orteping

the utility for easy creating of publications and subscriptions.

ortespy

monitors issues produced by other application in specific domain.

orteping

Name

`orteping` — the utility for debugging and testing of ORTE communication

Synopsis

orteping [`-d` *domain*] [`-p`] [`-S` *strength*] [`-D` *delay*] [`-s`] [`-R` *refresh*] [`-P` *purge*] [`-E` *expiration*] [`-m` *minimumSeparation*] [`-v` *verbosity*] [`-q`] [`-l` *filename*] [`-V`] [`-h`]

Description

Main purpose of the utility **orteping** is debug and test ORTE communication.

OPTIONS

`-d --domain`

The number of working ORTE domain. Default is 0.

`-p --publisher`

Create a publisher with Topic - Ping and Type - PingData. The publisher will publish a issue with period by parameter delay.

`-s --strength`

Setups relative weight against other publishers. Default is 1.

`-D --delay`

The time between two issues. Default 1 second.

`-s --subscriber`

Create a subscriber with Topic - Ping and Type - PingData.

`-R --refresh`

The refresh time in manager. Default 60 seconds.

`-P --purge`

The searching time in local database for finding expired application. Default 60 seconds.

`-E --expiration`

Expiration time in other applications.

`-m --minimumSeparation`

The minimum time between two issues.

`-v --verbosity`

Set verbosity level.

`-q --quite`

Nothing messages will be printed on screen. It can be useful for testing maximal throughput.

`-l --logfile`

All debug messages can be redirect into specific file.

`-V --version`

Print the version of **orteping**.

`-h --help`

Print usage screen.

ortespy

Name

`ortespy` — the utility for monitoring of ORTE issues

Synopsis

orteping [`-d` *`domain`*] [`-v` *`verbosity`*] [`-R` *`refresh`*] [`-P` *`purge`*] [`-e` *`expiration`*] [`-l` *`filename`*] [`-V`] [`-h`]

Description

Main purpose of the utility **ortespy** is monitoring data traffic between publications and subscriptions.

OPTIONS

`-d --domain`

The number of working ORTE domain. Default is 0.

`-v --verbosity`

Set verbosity level.

`-R --refresh`

The refresh time in manager. Default 60 seconds.

`-P --purge`

Create publisher

`-e --expiration`

Expiration time in other applications.

`-l --logfile`

All debug messages can be redirect into specific file.

`-V --version`

Print the version of **orteping**.

`-h --help`

Print usage screen.

Chapter 6. ORTE API

6.1. Data types

enum SubscriptionMode

Name

`enum SubscriptionMode` — mode of subscription

Synopsis

```
enum SubscriptionMode {
  PULLED,
  IMMEDIATE
};
```

Constants

PULLED

polled

IMMEDIATE

using callback function

Description

Specifies whether user application will poll for data or whether a callback function will be called by ORTE middleware when new data will be available.

enum SubscriptionType

Name

`enum SubscriptionType` — type of subcsription

Synopsis

```
enum SubscriptionType {
  BEST_EFFORTS,
  STRICT_RELIABLE
};
```

Constants

BEST_EFFORTS

best effort subscription

STRICT_RELIABLE

strict reliable subscription.

Description

Specifies which mode will be used for this subscription.

enum ORTERecvStatus

Name

`enum ORTERecvStatus` — status of a subscription

Synopsis

```
enum ORTERecvStatus {
  NEW_DATA,
  DEADLINE
};
```

Constants

NEW_DATA

new data has arrived

DEADLINE

deadline has occurred

Description

Specifies which event has occurred in the subscription object.

enum ORTESendStatus

Name

`enum ORTESendStatus` — status of a publication

Synopsis

```
enum ORTESendStatus {
  NEED_DATA,
  CQL
};
```

Constants

NEED_DATA

need new data (set when callback function specified for publciation is beeing called)

CQL

transmit queue has been filled up to critical level.

Description

Specifies which event has occurred in the publication object. Critical level of transmit queue is specified as one of publication properties (ORTEPublProp.criticalQueueLevel).

struct ORTEIFProp

Name

`struct ORTEIFProp` — interface flags

Synopsis

```
struct ORTEIFProp {
  int32_t ifFlags;
  IPAddress ipAddress;
};
```

Members

ifFlags

flags

ipAddress

IP address

Description

Flags for network interface.

struct ORTEMulticastProp

Name

`struct ORTEMulticastProp` — properties for ORTE multicast (not supported yet)

Synopsis

```
struct ORTEMulticastProp {
  Boolean enabled;
  unsigned char  ttl;
  Boolean loopBackEnabled;
  IPAddress ipAddress;
};
```

Members

enabled

ORTE_TRUE if multicast enabled otherwise ORTE_FALSE

ttl

time-to-live (TTL) for sent datagrams

loopBackEnabled

ORTE_TRUE if data should be received by sender itself otherwise ORTE_FALSE

ipAddress

desired multicast IP address

Description

Properties for ORTE multicast subsystem which is not fully supported yet. Multicast IP address is assigned by the ORTE middleware itself.

struct ORTEGetMaxSizeParam

Name

`struct ORTEGetMaxSizeParam` — parameters for function ORTETypeGetMaxSize

Synopsis

```
struct ORTEGetMaxSizeParam {
  CDR_Endianness host_endian;
  CDR_Endianness data_endian;
  CORBA_octet * data;
  unsigned int max_size;
  int recv_size;
  int csize;
};
```

Members

host_endian

data_endian

data

max_size

recv_size

csize

Description

It used to determine maximal size of intermal buffer for incomming data

struct ORTETypeRegister

Name

`struct ORTETypeRegister` — registered data type

Synopsis

```
struct ORTETypeRegister {
  const char            * typeName;
  ORTETypeSerialize serialize;
  ORTETypeDeserialize deserialize;
  ORTETypeGetMaxSize getMaxSize;
  unsigned int   maxSize;
};
```

Members

typeName

name of data type

serialize

pointer to serialization function

deserialize

pointer to deserialization function

getMaxSize

pointer to function given maximal data length

maxSize

maximal size of ser./deser. data

Description

Contains description of registered data type. See *ORTETypeRegisterAdd* function for details.

struct ORTEDomainBaseProp

Name

struct ORTEDomainBaseProp — base properties of a domain

Synopsis

```
struct ORTEDomainBaseProp {
  unsigned int   registrationMgrRetries;
  NtpTime registrationMgrPeriod;
  unsigned int   registrationAppRetries;
  NtpTime registrationAppPeriod;
  NtpTime expirationTime;
  NtpTime refreshPeriod;
  NtpTime purgeTime;
  NtpTime repeatAnnounceTime;
  NtpTime repeatActiveQueryTime;
  NtpTime delayResponceTimeACKMin;
  NtpTime delayResponceTimeACKMax;
  unsigned int           HBMaxRetries;
  unsigned int           ACKMaxRetries;
  NtpTime maxBlockTime;
};
```

Members

registrationMgrRetries

> a manager which want to start communication have to register to other manager. This parametr is used for specify maximal repetition retries of registration process when it fail.

registrationMgrPeriod

> an application which want to start communication have to register to a manager. This parametr is used for specify maximal repetition retries of registration process when it fail.

registrationAppRetries

> same like registrationMgrRetries parameter, but is used for an application

registrationAppPeriod

> repetition time for registration process

expirationTime

> specifies how long is this application taken as alive in other applications/managers (default 180s)

refreshPeriod

> how often an application refresh itself to its manager or manager to other managers (default 60s)

purgeTime

> how often the local database should be cleaned from invalid (expired) objects (default 60s)

repeatAnnounceTime

> This is the period with which the CSTWriter will announce its existence and/or the availability of new CSChanges to the CSTReader. This period determines how quickly the protocol recovers when an announcement of data is lost.

repeatActiveQueryTime

> ???

delayResponceTimeACKMin

> minimum time the CSTWriter waits before responding to an incoming message.

delayResponceTimeACKMax

> maximum time the CSTWriter waits before responding to an incoming message.

HBMaxRetries

how many times a HB message is retransmitted if no response has been received until timeout

ACKMaxRetries

how many times an ACK message is retransmitted if no response has been received until timeout

maxBlockTime

timeout for send functions if sending queue is full (default 30s)

struct ORTEDomainWireProp

Name

`struct ORTEDomainWireProp` — wire properties of a message

Synopsis

```
struct ORTEDomainWireProp {
  unsigned int          metaBytesPerPacket;
  unsigned int          metaBytesPerFastPacket;
  unsigned int          metabitsPerACKBitmap;
};
```

Members

metaBytesPerPacket

maximum number of bytes in single frame (default 1500B)

metaBytesPerFastPacket

maximum number of bytes in single frame if transmitting queue has reached *`criticalQueueLevel`* level (see *`ORTEPublProp`* struct)

metabitsPerACKBitmap

not supported yet (default 32)

struct ORTEPublProp

Name

`struct ORTEPublProp` — properties of a publication

Synopsis

```
struct ORTEPublProp {
  PathName topic;
  TypeName typeName;
  TypeChecksum typeChecksum;
  Boolean expectsAck;
  NtpTime persistence;
  uint32_t reliabilityOffered;
  uint32_t sendQueueSize;
  int32_t strength;
  uint32_t criticalQueueLevel;
  NtpTime HBNornalRate;
  NtpTime HBCQLRate;
  unsigned int           HBMaxRetries;
  NtpTime maxBlockTime;
};
```

Members

topic

the name of the information in the Network that is published or subscribed to

typeName

the name of the type of this data

typeChecksum

a checksum that identifies the CDR-representation of the data

expectsAck

indicates wherther publication expects to receive ACKs to its messages

persistence

indicates how long the issue is valid

reliabilityOffered

reliability policy as offered by the publication sendQueueSize

size of transmitting queue

strength

precedence of the issue sent by the publication

criticalQueueLevel

treshold for transmitting queue content length indicating the queue can became full immediately

HBNornalRate

how often send HBs to subscription objects

HBCQLRate

how often send HBs to subscription objects if transmittiong queue has reached *criticalQueueLevel*

HBMaxRetries

how many times retransmit HBs if no replay from target object has not been received

maxBlockTime

unsupported

struct ORTESubsProp

Name

`struct ORTESubsProp` — properties of a subscription

Synopsis

```
struct ORTESubsProp {
  PathName topic;
  TypeName typeName;
  TypeChecksum typeChecksum;
  NtpTime minimumSeparation;
  uint32_t recvQueueSize;
  uint32_t reliabilityRequested;
  //additional parametersNtpTime                deadline;
  uint32_t mode;
  IPAddress multicast;
};
```

Members

topic

the name of the information in the Network that is published or subscribed to

typeName

the name of the type of this data

typeChecksum

a checksum that identifies the CDR-representation of the data

minimumSeparation

minimum time between two consecutive issues received by the subscription

recvQueueSize

size of receiving queue

reliabilityRequested

reliability policy requested by the subscription

deadline

deadline for subscription, a callback function (see *ORTESubscriptionCreate*) will be called if no data were received within this period of time

mode

mode of subscription (strict reliable/best effort), see *SubscriptionType* enum for values

multicast

registered multicast IP address(read only)

struct ORTEAppInfo

Name

`struct ORTEAppInfo` —

Synopsis

```
struct ORTEAppInfo {
  HostId hostId;
  AppId appId;
  IPAddress * unicastIPAddressList;
  unsigned char          unicastIPAddressCount;
  IPAddress * metatrafficMulticastIPAddressList;
  unsigned char          metatrafficMulticastIPAddressCount;
  Port metatrafficUnicastPort;
  Port userdataUnicastPort;
  VendorId vendorId;
  ProtocolVersion protocolVersion;
};
```

Members

hostId

hostId of application

appId

appId of application

unicastIPAddressList

unicast IP addresses of the host on which the application runs (there can be multiple addresses on a multi-NIC host)

unicastIPAddressCount

number of IPaddresses in *unicastIPAddressList*

metatrafficMulticastIPAddressList

for the purposes of meta-traffic, an application can also accept Messages on this set of multicast addresses

metatrafficMulticastIPAddressCount

number of IPaddresses in *metatrafficMulticastIPAddressList*

metatrafficUnicastPort

UDP port used for metatraffic communication

userdataUnicastPort

UDP port used for metatraffic communication

vendorId

identifies the vendor of the middleware implementing the RTPS protocol and allows this vendor to add specific extensions to the protocol

protocolVersion

describes the protocol version

struct ORTEPubInfo

Name

`struct ORTEPubInfo` — information about publication

Synopsis

```
struct ORTEPubInfo {
  const char            * topic;
  const char            * type;
  ObjectId objectId;
};
```

Members

topic

    the name of the information in the Network that is published or subscribed to

type

    the name of the type of this data

objectId

    object providing this publication

struct ORTESubInfo

Name

`struct ORTESubInfo` — information about subscription

Synopsis

```
struct ORTESubInfo {
  const char            * topic;
  const char            * type;
  ObjectId objectId;
};
```

Members

topic

the name of the information in the Network that is published or subscribed to

type

the name of the type of this data

objectId

object with this subscription

struct ORTEPublStatus

Name

`struct ORTEPublStatus` — status of a publication

Synopsis

```
struct ORTEPublStatus {
  unsigned int          strict;
  unsigned int          bestEffort;
  unsigned int          issues;
};
```

Members

strict

count of unreliable subscription (strict) connected on responsible subscription

bestEffort

count of reliable subscription (best effort) connected on responsible subscription issues

number of messages in transmitting queue

struct ORTESubsStatus

Name

`struct ORTESubsStatus` — status of a subscription

Synopsis

```
struct ORTESubsStatus {
  unsigned int           strict;
  unsigned int           bestEffort;
  unsigned int           issues;
};
```

Members

strict

count of unreliable publications (strict) connected to responsible subscription

bestEffort

count of reliable publications (best effort) connected to responsible subscription

issues

number of messages in receiving queue

struct ORTERecvInfo

Name

`struct ORTERecvInfo` — description of received data

Synopsis

```
struct ORTERecvInfo {
  ORTERecvStatus status;
  const char            * topic;
  const char            * type;
  GUID_RTPS senderGUID;
  NtpTime localTimeReceived;
  NtpTime remoteTimePublished;
  SequenceNumber sn;
};
```

Members

status

status of this event

topic

the name of the information

type

the name of the type of this data

senderGUID

GUID of object who sent this information

localTimeReceived

local timestamp when data were received

remoteTimePublished

remote timestam when data were published

sn

sequencial number of data

struct ORTESendInfo

Name

`struct ORTESendInfo` — description of sending data

Synopsis

```
struct ORTESendInfo {
  ORTESendStatus status;
  const char            * topic;
  const char            * type;
  GUID_RTPS senderGUID;
  SequenceNumber sn;
};
```

Members

status

status of this event

topic

the name of the information

type

the name of the type of this information

senderGUID

GUID of object who sent this information

sn

sequencial number of information

struct ORTEPublicationSendParam

Name

`struct ORTEPublicationSendParam` — description of sending data

Synopsis

```
struct ORTEPublicationSendParam {
  void * instance;
  int data_endian;
};
```

Members

instance

pointer to new data instance

data_endian

endianing of sending data (BIG | LITTLE)

struct ORTEDomainAppEvents

Name

`struct ORTEDomainAppEvents` — Domain event handlers of an application

Synopsis

```
struct ORTEDomainAppEvents {
  ORTEOnRegFail onRegFail;
  void * onRegFailParam;
  ORTEOnMgrNew onMgrNew;
  void * onMgrNewParam;
  ORTEOnMgrDelete onMgrDelete;
  void * onMgrDeleteParam;
  ORTEOnAppRemoteNew onAppRemoteNew;
  void * onAppRemoteNewParam;
  ORTEOnAppDelete onAppDelete;
  void * onAppDeleteParam;
  ORTEOnPubRemote onPubRemoteNew;
  void * onPubRemoteNewParam;
  ORTEOnPubRemote onPubRemoteChanged;
  void * onPubRemoteChangedParam;
  ORTEOnPubDelete onPubDelete;
  void * onPubDeleteParam;
  ORTEOnSubRemote onSubRemoteNew;
  void * onSubRemoteNewParam;
  ORTEOnSubRemote onSubRemoteChanged;
  void * onSubRemoteChangedParam;
  ORTEOnSubDelete onSubDelete;
  void * onSubDeleteParam;
};
```

Members

onRegFail

registration protocol has been failed

onRegFailParam

user parameters for *`onRegFail`* handler

onMgrNew

new manager has been created

onMgrNewParam

user parameters for *`onMgrNew`* handler

onMgrDelete

manager has been deleted

onMgrDeleteParam

user parameters for *`onMgrDelete`* handler

onAppRemoteNew

new remote application has been registered

onAppRemoteNewParam

user parameters for *`onAppRemoteNew`* handler

onAppDelete

an application has been removed

onAppDeleteParam

user parameters for *`onAppDelete`* handler

onPubRemoteNew

new remote publication has been registered

onPubRemoteNewParam

user parameters for *`onPubRemoteNew`* handler

onPubRemoteChanged

a remote publication's parameters has been changed

onPubRemoteChangedParam

user parameters for *`onPubRemoteChanged`* handler onPubDelete

a publication has been deleted

onPubDeleteParam

user parameters for `onPubDelete` handler

onSubRemoteNew

a new remote subscription has been registered

onSubRemoteNewParam

user parameters for `onSubRemoteNew` handler

onSubRemoteChanged

a remote subscription's parameters has been changed

onSubRemoteChangedParam

user parameters for `onSubRemoteChanged` handler

onSubDelete

a publication has been deleted

onSubDeleteParam

user parameters for `onSubDelete` handler

Description

Prototypes of events handler fucntions can be found in file typedefs_api.h.

struct ORTETasksProp

Name

`struct ORTETasksProp` — ORTE task properties, not supported

Synopsis

```
struct ORTETasksProp {
  Boolean realTimeEnabled;
  int smtStackSize;
  int smtPriority;
  int rmtStackSize;
  int rmtPriority;
};
```

Members

realTimeEnabled

not supported

smtStackSize

not supported

smtPriority

not supported

rmtStackSize

not supported

rmtPriority

not supported

struct ORTEDomainProp

Name

`struct ORTEDomainProp` — domain properties

Synopsis

```
struct ORTEDomainProp {
  ORTETasksProp tasksProp;
  ORTEIFProp * IFProp;
  //interface propertiesunsigned char          IFCount;
  //count of interfacesORTEDomainBaseProp     baseProp;
  ORTEDomainWireProp wireProp;
  ORTEMulticastProp multicast;
  //multicast properiesORTEPublProp           publPropDefault;
  //default properties for a Publ/SubORTESubsProp           subsPropDefault;
  char * mgrs;
  //managerschar * keys;
  //keysIPAddress appLocalManager;
  //applicationsIPAddress listen;
  char * version;
  //string product versionint                    recvBuffSize;
  int sendBuffSize;
};
```

Members

tasksProp

task properties

IFProp

properties of network interfaces

IFCount

number of network interfaces

baseProp

base properties (see *ORTEDomainBaseProp* for details)

wireProp

wire properties (see *ORTEDomainWireProp* for details)

multicast

multicast properties (see *ORTEMulticastProp* for details)

publPropDefault

default properties of publiciations (see *ORTEPublProp* for details)

subsPropDefault

default properties of subscriptions (see *ORTESubsProp* for details)

mgrs

list of known managers

keys

access keys for managers

appLocalManager

IP address of local manager (default localhost)

listen

IP address to listen on

version

string product version

recvBuffSize

receiving queue length

sendBuffSize

transmitting queue length

6.2. Functions

IPAddressToString

Name

`IPAddressToString` — converts IP address IPAddress to its string representation

Synopsis

```
char* IPAddressToString (IPAddress ipAddress, char * buff);
```

Arguments

`ipAddress`

source IP address

`buff`

output buffer

StringToIPAddress

Name

`StringToIPAddress` — converts IP address from string into IPAddress

Synopsis

```
IPAddress StringToIPAddress (const char * string);
```

Arguments

string

source string

NtpTimeToStringMs

Name

`NtpTimeToStringMs` — converts NtpTime to its text representation in miliseconds

Synopsis

```
char * NtpTimeToStringMs (NtpTime time, char * buff);
```

Arguments

time

time given in NtpTime structure

buff

output buffer

NtpTimeToStringUs

Name

`NtpTimeToStringUs` — converts NtpTime to its text representation in microseconds

Synopsis

```
char * NtpTimeToStringUs (NtpTime time, char * buff);
```

Arguments

`time`

time given in NtpTime structure

`buff`

output buffer

ORTEDomainStart

Name

`ORTEDomainStart` — start specific threads

Synopsis

```
void ORTEDomainStart (ORTEDomain * d, Boolean recvUnicastMetatrafficThread,
Boolean recvMulticastMetatrafficThread, Boolean recvUnicastUserdataThread,
Boolean recvMulticastUserdataThread, Boolean sendThread);
```

Arguments

d

domain object handle

recvUnicastMetatrafficThread

specifies whether recvUnicastMetatrafficThread should be started (ORTE_TRUE) or remain suspended (ORTE_FALSE).

recvMulticastMetatrafficThread

specifies whether recvMulticastMetatrafficThread should be started (ORTE_TRUE) or remain suspended (ORTE_FALSE).

recvUnicastUserdataThread

specifies whether recvUnicastUserdataThread should be started (ORTE_TRUE) or remain suspended (ORTE_FALSE).

recvMulticastUserdataThread

specifies whether recvMulticastUserdataThread should be started (ORTE_TRUE) or remain suspended (ORTE_FALSE).

sendThread

specifies whether sendThread should be started (ORTE_TRUE) or remain suspended (ORTE_FALSE).

Description

Functions *ORTEDomainAppCreate* and *ORTEDomainMgrCreate* provide facility to create an object with its threads suspended. Use function *ORTEDomainStart* to resume those suspended threads.

ORTEDomainPropDefaultGet

Name

ORTEDomainPropDefaultGet — returns default properties of a domain

Synopsis

```
Boolean ORTEDomainPropDefaultGet (ORTEDomainProp * prop);
```

Arguments

prop

pointer to struct ORTEDomainProp

Description

Structure ORTEDomainProp referenced by *prop* will be filled by its default values. Returns ORTE_TRUE if successful or ORTE_FALSE in case of any error.

ORTEDomainInitEvents

Name

ORTEDomainInitEvents — initializes list of events

Synopsis

```
Boolean ORTEDomainInitEvents (ORTEDomainAppEvents * events);
```

Arguments

events

pointer to struct ORTEDomainAppEvents

Description

Initializes structure pointed by *events*. Every member is set to NULL. Returns ORTE_TRUE if successful or ORTE_FALSE in case of any error.

ORTEDomainAppCreate

Name

`ORTEDomainAppCreate` — creates an application object within given domain

Synopsis

```
ORTEDomain * ORTEDomainAppCreate (int domain, ORTEDomainProp * prop,
ORTEDomainAppEvents * events, Boolean suspended);
```

Arguments

domain

given domain

prop

properties of application

events

events associated with application or NULL

suspended

specifies whether threads of this application should be started as well (ORTE_FALSE) or stay suspended (ORTE_TRUE). See *ORTEDomainStart* for details how to resume suspended threads

Description

Creates new Application object and sets its properties and events. Return handle to created object or NULL in case of any error.

ORTEDomainAppDestroy

Name

`ORTEDomainAppDestroy` — destroy Application object

Synopsis

```
Boolean ORTEDomainAppDestroy (ORTEDomain * d);
```

Arguments

d

domain

Description

Destroys all application objects in specified domain. Returns ORTE_TRUE or ORTE_FALSE in case of any error.

ORTEDomainAppSubscriptionPatternAdd

Name

`ORTEDomainAppSubscriptionPatternAdd` — create pattern-based subscription

Synopsis

```
Boolean ORTEDomainAppSubscriptionPatternAdd (ORTEDomain * d, const char *
topic, const char * type, ORTESubscriptionPatternCallBack
subscriptionCallBack, void * param);
```

Arguments

d

domain object

topic

pattern for topic

type

pattern for type

subscriptionCallBack

pointer to callback function which will be called whenever any data are received through this subscription

param

user params for callback function

Description

This function is intended to be used in application interesded in more published data from possibly more remote applications, which should be received through single subscription. These different publications are specified by pattern given to *topic* and *type* parameters.

For example suppose there are publications of topics like *temperatureEngine1*, *temperatureEngine2*, *temperatureEngine1Backup* and *temperatureEngine2Backup* somewhere on our network. We can subscribe to each of Engine1 temperations by creating single subscription with pattern for topic set to “temperatureEngine1*”. Or, if we are interested only in values from backup measurements, we can use pattern “*Backup”.

Syntax for patterns is the same as syntax for *fnmatch* function, which is employed for pattern recognition.

Returns ORTE_TRUE if successful or ORTE_FALSE in case of any error.

ORTEDomainAppSubscriptionPatternRemove

Name

`ORTEDomainAppSubscriptionPatternRemove` — remove subscription pattern

Synopsis

```
Boolean ORTEDomainAppSubscriptionPatternRemove (ORTEDomain * d, const char *
topic, const char * type);
```

Arguments

d

domain handle

topic

pattern to be removed

type

pattern to be removed

Description

Removes subscritions created by *ORTEDomainAppSubscriptionPatternAdd*. Patterns for *type* and *topic* must be exactly the same strings as when *ORTEDomainAppSubscriptionPatternAdd* function was called.

Returns ORTE_TRUE if successful or ORTE_FALSE if none matching record was found

ORTEDomainAppSubscriptionPatternDestroy

Name

ORTEDomainAppSubscriptionPatternDestroy — destroys all subscription patterns

Synopsis

```
Boolean ORTEDomainAppSubscriptionPatternDestroy (ORTEDomain * d);
```

Arguments

d

domain handle

Description

Destroys all subscription patterns which were specified previously by *ORTEDomainAppSubscriptionPatternAdd* function.

Returns ORTE_TRUE if successful or ORTE_FALSE in case of any error.

ORTEDomainMgrCreate

Name

ORTEDomainMgrCreate — create manager object in given domain

Synopsis

```
ORTEDomain * ORTEDomainMgrCreate (int domain, ORTEDomainProp * prop,
ORTEDomainAppEvents * events, Boolean suspended);
```

Arguments

domain

given domain

prop

desired manager's properties

events

manager's event handlers or NULL

suspended

specifies whether threads of this manager should be started as well (ORTE_FALSE) or stay suspended (ORTE_TRUE). See *ORTEDomainStart* for details how to resume suspended threads

Description

Creates new manager object and sets its properties and events. Return handle to created object or NULL in case of any error.

ORTEDomainMgrDestroy

Name

`ORTEDomainMgrDestroy` — destroy manager object

Synopsis

```
Boolean ORTEDomainMgrDestroy (ORTEDomain * d);
```

Arguments

d

manager object to be destroyed

Description

Returns ORTE_TRUE if successful or ORTE_FALSE in case of any error.

ORTEPublicationCreate

Name

`ORTEPublicationCreate` — creates new publication

Synopsis

ORTEPublication * **ORTEPublicationCreate** (ORTEDomain * *d*, const char * *topic*, const char * *typeName*, void * *instance*, NtpTime * *persistence*, int *strength*, ORTESendCallBack *sendCallBack*, void * *sendCallBackParam*, NtpTime * *sendCallBackDelay*);

Arguments

d

pointer to application object

topic

name of topic

typeName

data type description

instance

output buffer where application stores data for publication

persistence

persistence of publication

strength

strength of publication

sendCallBack

pointer to callback function

sendCallBackParam

user parameters for callback function

sendCallBackDelay

periode for timer which issues callback function

Description

Creates new publication object with specified parameters. The *sendCallBack* function is called periodically with *sendCallBackDelay* periode. In strict reliable mode the *sendCallBack* function will be called only if there is enough room in transmitting queue in order to prevent any data loss. The *sendCallBack* function should prepare data to be published by this publication and place them into *instance* buffer.

Returns handle to publication object.

ORTEPublicationDestroy

Name

ORTEPublicationDestroy — removes a publication

Synopsis

```
int ORTEPublicationDestroy (ORTEPublication * cstWriter);
```

Arguments

cstWriter

handle to publication to be removed

Description

Returns ORTE_OK if successful or ORTE_BAD_HANDLE if *cstWriter* is not valid cstWriter handle.

ORTEPublicationPropertiesGet

Name

ORTEPublicationPropertiesGet — read properties of a publication

Synopsis

```
ORTEPublicationPropertiesGet (ORTEPublication * cstWriter, ORTEPublProp *
pp);
```

Arguments

cstWriter

pointer to cstWriter object which provides this publication

pp

pointer to ORTEPublProp structure where values of publication's properties will be stored

Description

Returns ORTE_OK if successful or ORTE_BAD_HANDLE if *cstWriter* is not valid cstWriter handle.

ORTEPublicationPropertiesSet

Name

ORTEPublicationPropertiesSet — set properties of a publication

Synopsis

```
int ORTEPublicationPropertiesSet (ORTEPublication * cstWriter, ORTEPublProp *
pp);
```

Arguments

cstWriter

pointer to cstWriter object which provides this publication *`pp`*

pointer to ORTEPublProp structure containing values of publication's properties

Description

Returns ORTE_OK if successful or ORTE_BAD_HANDLE if *`cstWriter`* is not valid publication handle.

ORTEPublicationGetStatus

Name

`ORTEPublicationGetStatus` — removes a publication

Synopsis

```
int ORTEPublicationGetStatus (ORTEPublication * cstWriter, ORTEPublStatus *
status);
```

Arguments

`cstWriter`

pointer to cstWriter object which provides this publication

`status`

pointer to ORTEPublStatus structure

Description

Returns ORTE_OK if successful or ORTE_BAD_HANDLE if *`happ`* is not valid publication handle.

ORTEPublicationSend

Name

`ORTEPublicationSend` — force publication object to issue new data

Synopsis

```
int ORTEPublicationSend (ORTEPublication * cstWriter);
```

Arguments

cstWriter

publication object

Description

Returns ORTE_OK if successful.

ORTEPublicationSendEx

Name

`ORTEPublicationSendEx` — force publication object to issue new data with additional parameters

Synopsis

```
int ORTEPublicationSendEx (ORTEPublication * cstWriter,
ORTEPublicationSendParam * psp);
```

Arguments

cstWriter

publication object

psp

publication parameters

Description

Returns ORTE_OK if successful.

ORTEPublicationGetInstance

Name

`ORTEPublicationGetInstance` — return pointer to an instance

Synopsis

```
void * ORTEPublicationGetInstance (ORTEPublication * cstWriter);
```

Arguments

cstWriter

publication object

Description

Returns handle

ORTESubscriptionCreate

Name

`ORTESubscriptionCreate` — adds a new subscription

Synopsis

```
ORTESubscription * ORTESubscriptionCreate (ORTEDomain * d, SubscriptionMode
mode, SubscriptionType sType, const char * topic, const char * typeName, void
* instance, NtpTime * deadline, NtpTime * minimumSeparation, ORTERecvCallBack
recvCallBack, void * recvCallBackParam, IPAddress multicastIPAddress);
```

Arguments

d

pointer to ORTEDomain object where this subscription will be created

mode

see enum SubscriptionMode

sType

see enum SubscriptionType

topic

name of topic

typeName

name of data type

instance

pointer to output buffer

deadline

deadline

minimumSeparation

minimum time interval between two publications sent by Publisher as requested by Subscriber (strict - minumSep musi byt 0) *`recvCallBack`*

callback function called when new Subscription has been received or if any change of subscription's status occures

`recvCallBackParam`

user parameters for *`recvCallBack`*

`multicastIPAddress`

in case multicast subscripton specify multicast IP address or use IPADDRESS_INVALID to unicast communication

Description

Returns handle to Subscription object.

ORTESubscriptionDestroy

Name

`ORTESubscriptionDestroy` — removes a subscription

Synopsis

```
int ORTESubscriptionDestroy (ORTESubscription * cstReader);
```

Arguments

`cstReader`

handle to subscriotion to be removed

Description

Returns ORTE_OK if successful or ORTE_BAD_HANDLE if *`cstReader`* is not valid subscription handle.

ORTESubscriptionPropertiesGet

Name

`ORTESubscriptionPropertiesGet` — get properties of a subscription

Synopsis

```
int ORTESubscriptionPropertiesGet (ORTESubscription * cstReader, ORTESubsProp
* sp);
```

Arguments

cstReader

handle to publication

sp

pointer to ORTESubsProp structure where properties of subscrition will be stored

ORTESubscriptionPropertiesSet

Name

`ORTESubscriptionPropertiesSet` — set properties of a subscription

Synopsis

```
int ORTESubscriptionPropertiesSet (ORTESubscription * cstReader, ORTESubsProp
* sp);
```

Arguments

cstReader

handle to publication

sp

pointer to ORTESubsProp structure containing desired properties of the subscription

Description

Returns ORTE_OK if successful or ORTE_BAD_HANDLE if *cstReader* is not valid subscription handle.

ORTESubscriptionWaitForPublications

Name

`ORTESubscriptionWaitForPublications` — waits for given number of publications

Synopsis

```
int ORTESubscriptionWaitForPublications (ORTESubscription * cstReader,
NtpTime wait, unsigned int retries, unsigned int noPublications);
```

Arguments

cstReader

handle to subscription

wait

time how long to wait

retries

number of retries if specified number of publications was not reached *noPublications*

desired number of publications

Description

Returns ORTE_OK if successful or ORTE_BAD_HANDLE if *cstReader* is not valid subscription handle or ORTE_TIMEOUT if number of retries has been exhausted..

ORTESubscriptionGetStatus

Name

`ORTESubscriptionGetStatus` — get status of a subscription

Synopsis

```
int ORTESubscriptionGetStatus (ORTESubscription * cstReader, ORTESubsStatus *
status);
```

Arguments

cstReader

handle to subscription

status

pointer to ORTESubsStatus structure

Description

Returns ORTE_OK if successful or ORTE_BAD_HANDLE if *cstReader* is not valid subscription handle.

ORTESubscriptionPull

Name

`ORTESubscriptionPull` — read data from receiving buffer

Synopsis

```
int ORTESubscriptionPull (ORTESubscription * cstReader);
```

Arguments

`cstReader`

handle to subscription

Description

Returns ORTE_OK if successful or ORTE_BAD_HANDLE if *`cstReader`* is not valid subscription handle.

ORTESubscriptionGetInstance

Name

`ORTESubscriptionGetInstance` — return pointer to an instance

Synopsis

```
void * ORTESubscriptionGetInstance (ORTESubscription * cstReader);
```

Arguments

cstReader

publication object

Description

Returns handle

ORTETypeRegisterAdd

Name

ORTETypeRegisterAdd — register new data type

Synopsis

```
int ORTETypeRegisterAdd (ORTEDomain * d, const char * typeName,
ORTETypeSerialize ts, ORTETypeDeserialize ds, ORTETypeGetMaxSize gms,
unsigned int ms);
```

Arguments

d

domain object handle

typeName

name of data type

ts

pointer to serialization function. If NULL data will be copied without any processing.

ds

deserialization function. If NULL data will be copied without any processing.

gms

pointer to a function given maximum length of data (in bytes)

ms

default maximal size

Description

Each data type has to be registered. Main purpose of this process is to define serialization and deserialization functions for given data type. The same data type can be registered several times, previous registrations of the same type will be overwritten.

Examples of serialization and deserialization functions can be found if contrib/shape/ortedemo_types.c file.

Returns ORTE_OK if new data type has been succesfully registered.

ORTETypeRegisterDestroyAll

Name

`ORTETypeRegisterDestroyAll` — destroy all registered data types

Synopsis

```
int ORTETypeRegisterDestroyAll (ORTEDomain * d);
```

Arguments

d

domain object handle

Description

Destroys all data types which were previously registered by function *`ORTETypeRegisterAdd`*.

Return ORTE_OK if all data types has been succesfully destroyed.

ORTEVerbositySetOptions

Name

`ORTEVerbositySetOptions` — set verbosity options

Synopsis

```
void ORTEVerbositySetOptions (const char * options);
```

Arguments

`options`

verbosity options

Description

There are 10 levels of verbosity ranging from 1 (lowest) to 10 (highest). It is possible to specify certain level of verbosity for each module of ORTE library. List of all supported modules can be found in linorte/usedSections.txt file. Every module has been aasigned with a number as can be seen in usedSections.txt file.

For instance

options = “ALL,7” Verbosity will be set to level 7 for all modules.

options = “51,7:32,5” Modules 51 (RTPSCSTWrite.c) will use verbosity level 7 and module 32 (ORTEPublicationTimer.c) will use verbosity level 5.

Maximum number of modules and verbosity levels can be changed in order to save some memory space if small memory footprint is neccessary. These values are defined as macros MAX_DEBUG_SECTIONS and MAX_DEBUG_LEVEL in file `include`/defines.h.

Return ORTE_OK if desired verbosity levels were successfuly set.

ORTEVerbositySetLogFile

Name

`ORTEVerbositySetLogFile` — set log file

Synopsis

```
void ORTEVerbositySetLogFile (const char * logfile);
```

Arguments

logfile

log file name

Description

Sets output file where debug messages will be writen to. By default these messages are written to stdout.

ORTEInit

Name

`ORTEInit` — initialization of ORTE layer (musi se zavolat)

Synopsis

```
void ORTEInit ( void);
```

Arguments

void

no arguments

ORTESleepMs

Name

`ORTESleepMs` — suspends calling thread for given time

Synopsis

```
void ORTESleepMs (unsigned int ms);
```

Arguments

ms

miliseconds to sleep

6.3. Macros

SeqNumberCmp

Name

`SeqNumberCmp` — comparison of two sequence numbers

Synopsis

```
SeqNumberCmp ( sn1,  sn2);
```

Arguments

sn1

source sequential number 1

sn2

source sequential number 2

Return

1 if sn1 > sn2 -1 if sn1 < sn2 0 if sn1 = sn2

SeqNumberInc

Name

`SeqNumberInc` — incrementation of a sequence number

Synopsis

```
SeqNumberInc ( res,  sn);
```

Arguments

`res`

result

`sn`

sequential number to be incremented

Description

res = sn + 1

SeqNumberAdd

Name

`SeqNumberAdd` — addition of two sequential numbers

Synopsis

```
SeqNumberAdd ( res,  sn1,  sn2);
```

Arguments

`res`

result

`sn1`

source sequential number 1

`sn2`

source sequential number 2

Description

res = sn1 + sn2

SeqNumberDec

Name

`SeqNumberDec` — decrementation of a sequence number

Synopsis

```
SeqNumberDec ( res,  sn);
```

Arguments

res

result

sn

sequential number to be decremented

Description

res = sn - 1

SeqNumberSub

Name

`SeqNumberSub` — substraction of two sequential numbers

Synopsis

SeqNumberSub (*res*, *sn1*, *sn2*);

Arguments

res

result

sn1

source sequential number 1

sn2

source sequential number 2

Description

res = sn1 - sn2

NtpTimeCmp

Name

`NtpTimeCmp` — comparation of two NtpTimes

Synopsis

NtpTimeCmp (*time1*, *time2*);

Arguments

time1

source time 1

`time2`

source time 2

Return value

1 if time 1 > time 2 -1 if time 1 < time 2 0 if time 1 = time 2

NtpTimeAdd

Name

`NtpTimeAdd` — addition of two NtpTimes

Synopsis

`NtpTimeAdd` `(` *`res`*`,` *`time1`*`,` *`time2`*`);`

Arguments

`res`

result

`time1`

source time 1

`time2`

source time 2

Description

res = time1 + time2

NtpTimeSub

Name

`NtpTimeSub` — substraction of two NtpTimes

Synopsis

```
NtpTimeSub ( res,  time1,  time2);
```

Arguments

res

result

time1

source time 1

time2

source time 2

Description

res = time1 - time2

NtpTimeAssembFromMs

Name

`NtpTimeAssembFromMs` — converts seconds and miliseconds to NtpTime

Synopsis

```
NtpTimeAssembFromMs ( time,  s,  msec);
```

Arguments

`time`

time given in NtpTime structure

`s`

seconds portion of given time

`msec`

miliseconds portion of given time

NtpTimeDisAssembToMs

Name

`NtpTimeDisAssembToMs` — converts NtpTime to seconds and miliseconds

Synopsis

```
NtpTimeDisAssembToMs ( s,  msec,  time);
```

Arguments

`s`

seconds portion of given time

`msec`

miliseconds portion of given time

`time`

time given in NtpTime structure

NtpTimeAssembFromUs

Name

`NtpTimeAssembFromUs` — converts seconds and useconds to NtpTime

Synopsis

```
NtpTimeAssembFromUs ( time,  s,  usec);
```

Arguments

time

time given in NtpTime structure

s

seconds portion of given time

usec

microseconds portion of given time

NtpTimeDisAssembToUs

Name

`NtpTimeDisAssembToUs` — converts NtpTime to seconds and useconds

Synopsis

```
NtpTimeDisAssembToUs ( s,  usec,  time);
```

Arguments

s

seconds portion of given time

usec

microseconds portion of given time

time

time given in NtpTime structure

Domain2Port

Name

`Domain2Port` — converts Domain value to IP Port value

Synopsis

```
Domain2Port ( d,  p);
```

Arguments

d

domain

p

port

Domain2PortMulticastUserdata

Name

`Domain2PortMulticastUserdata` — converts Domain value to userdata IP Port value

Synopsis

```
Domain2PortMulticastUserdata ( d,  p);
```

Arguments

d

domain

p

port

Domain2PortMulticastMetatraffic

Name

`Domain2PortMulticastMetatraffic` — converts Domain value to metatraffic IP Port value

Synopsis

```
Domain2PortMulticastMetatraffic ( d,  p);
```

Arguments

d

domain

p

port