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P. Leach

Request for Comments: 4122
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July 2005

A Universally Unique Identifier (UUID) URN Namespace

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Abstract

This specification defines a Uniform Resource Name namespace for UUIDs (Universally Unique Identifier), also known as GUIDs (Globally Unique Identifier). A UUID is 128 bits long, and can guarantee uniqueness across space and time. UUIDs were originally used in the Apollo Network Computing System and later in the Open Software Foundation's (OSF) Distributed Computing Environment (DCE), and then in Microsoft Windows platforms.

This specification is derived from the DCE specification with the kind permission of the OSF (now known as The Open Group). Information from earlier versions of the DCE specification have been incorporated into this document.

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1. Introduction

This specification defines a Uniform Resource Name namespace for UUIDs (Universally Unique IDentifier), also known as GUIDs (Globally Unique IDentifier). A UUID is 128 bits long, and requires no central registration process.

The information here is meant to be a concise guide for those wishing to implement services using UUIDs as URNs. Nothing in this document should be construed to override the DCE standards that defined UUIDs.

There is an ITU-T Recommendation and ISO/IEC Standard [3] that are

derived from earlier versions of this document. Both sets of specifications have been aligned, and are fully technically compatible. In addition, a global registration function is being provided by the Telecommunications Standardisation Bureau of ITU-T; for details see <<http://www.itu.int/ITU-T/asn1/uuid.html>>.

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2. Motivation

One of the main reasons for using UUIDs is that no centralized authority is required to administer them (although one format uses IEEE 802 node identifiers, others do not). As a result, generation on demand can be completely automated, and used for a variety of purposes. The UUID generation algorithm described here supports very high allocation rates of up to 10 million per second per machine if necessary, so that they could even be used as transaction IDs.

UUIDs are of a fixed size (128 bits) which is reasonably small compared to other alternatives. This lends itself well to sorting, ordering, and hashing of all sorts, storing in databases, simple allocation, and ease of programming in general.

Since UUIDs are unique and persistent, they make excellent Uniform Resource Names. The unique ability to generate a new UUID without a registration process allows for UUIDs to be one of the URNs with the lowest minting cost.

3. Namespace Registration Template

Namespace ID: UUID

Registration Information:

Registration date: 2003-10-01

Declared registrant of the namespace:

JTC 1/SC6 (ASN.1 Rapporteur Group)

Declaration of syntactic structure:

A UUID is an identifier that is unique across both space and time, with respect to the space of all UUIDs. Since a UUID is a fixed size and contains a time field, it is possible for values to

rollover (around A.D. 3400, depending on the specific algorithm used). A UUID can be used for multiple purposes, from tagging objects with an extremely short lifetime, to reliably identifying very persistent objects across a network.

The internal representation of a UUID is a specific sequence of bits in memory, as described in Section 4. To accurately represent a UUID as a URN, it is necessary to convert the bit sequence to a string representation.

Each field is treated as an integer and has its value printed as a zero-filled hexadecimal digit string with the most significant digit first. The hexadecimal values "a" through "f" are output as lower case characters and are case insensitive on input.

| | | |
|---------------|----------------------|-----------|
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The formal definition of the UUID string representation is provided by the following ABNF [7]:

```
UUID           = time-low "-" time-mid "-"
                time-high-and-version "-"
                clock-seq-and-reserved
                clock-seq-low "-" node
time-low       = 4hexOctet
time-mid       = 2hexOctet
time-high-and-version = 2hexOctet
clock-seq-and-reserved = hexOctet
clock-seq-low  = hexOctet
node           = 6hexOctet
hexOctet       = hexDigit hexDigit
hexDigit =
    "0" / "1" / "2" / "3" / "4" / "5" / "6" / "7" / "8" / "9" /
    "a" / "b" / "c" / "d" / "e" / "f" /
    "A" / "B" / "C" / "D" / "E" / "F"
```

The following is an example of the string representation of a UUID as a URN:

```
urn:uuid:f81d4fae-7dec-11d0-a765-00a0c91e6bf6
```

Relevant ancillary documentation:

[1][2]

Identifier uniqueness considerations:

This document specifies three algorithms to generate UUIDs: the first leverages the unique values of 802 MAC addresses to guarantee uniqueness, the second uses pseudo-random number generators, and the third uses cryptographic hashing and application-provided text strings. As a result, the UUIDs generated according to the mechanisms here will be unique from all other UUIDs that have been or will be assigned.

Identifier persistence considerations:

UUIDs are inherently very difficult to resolve in a global sense. This, coupled with the fact that UUIDs are temporally unique within their spatial context, ensures that UUIDs will remain as persistent as possible.

Process of identifier assignment:

Generating a UUID does not require that a registration authority be contacted. One algorithm requires a unique value over space for each generator. This value is typically an IEEE 802 MAC address, usually already available on network-connected hosts. The address can be assigned from an address block obtained from the IEEE registration authority. If no such address is available,

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or privacy concerns make its use undesirable, Section 4.5 specifies two alternatives. Another approach is to use version 3 or version 4 UUIDs as defined below.

Process for identifier resolution:

Since UUIDs are not globally resolvable, this is not applicable.

Rules for Lexical Equivalence:

Consider each field of the UUID to be an unsigned integer as shown in the table in section Section 4.1.2. Then, to compare a pair of UUIDs, arithmetically compare the corresponding fields from each UUID in order of significance and according to their data type. Two UUIDs are equal if and only if all the corresponding fields are equal.

As an implementation note, equality comparison can be performed on many systems by doing the appropriate byte-order canonicalization,

and then treating the two UUIDs as 128-bit unsigned integers.

UUIDs, as defined in this document, can also be ordered lexicographically. For a pair of UUIDs, the first one follows the second if the most significant field in which the UUIDs differ is greater for the first UUID. The second precedes the first if the most significant field in which the UUIDs differ is greater for the second UUID.

Conformance with URN Syntax:

The string representation of a UUID is fully compatible with the URN syntax. When converting from a bit-oriented, in-memory representation of a UUID into a URN, care must be taken to strictly adhere to the byte order issues mentioned in the string representation section.

Validation mechanism:

Apart from determining whether the timestamp portion of the UUID is in the future and therefore not yet assignable, there is no mechanism for determining whether a UUID is 'valid'.

Scope:

UUIDs are global in scope.

4. Specification

4.1. Format

The UUID format is 16 octets; some bits of the eight octet variant field specified below determine finer structure.

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4.1.1. Variant

The variant field determines the layout of the UUID. That is, the interpretation of all other bits in the UUID depends on the setting of the bits in the variant field. As such, it could more accurately be called a type field; we retain the original term for compatibility. The variant field consists of a variable number of the most significant bits of octet 8 of the UUID.

The following table lists the contents of the variant field, where the letter "x" indicates a "don't-care" value.

| Msb0 | Msb1 | Msb2 | Description |
|------|------|------|--|
| 0 | x | x | Reserved, NCS backward compatibility. |
| 1 | 0 | x | The variant specified in this document. |
| 1 | 1 | 0 | Reserved, Microsoft Corporation backward compatibility |
| 1 | 1 | 1 | Reserved for future definition. |

Interoperability, in any form, with variants other than the one defined here is not guaranteed, and is not likely to be an issue in practice.

4.1.2. Layout and Byte Order

To minimize confusion about bit assignments within octets, the UUID record definition is defined only in terms of fields that are integral numbers of octets. The fields are presented with the most significant one first.

| Field | Data Type | Octet # | Note |
|---------------------|-------------------------|---------|---|
| time_low | unsigned 32 bit integer | 0-3 | The low field of the timestamp |
| time_mid | unsigned 16 bit integer | 4-5 | The middle field of the timestamp |
| time_hi_and_version | unsigned 16 bit integer | 6-7 | The high field of the timestamp multiplexed with the version number |

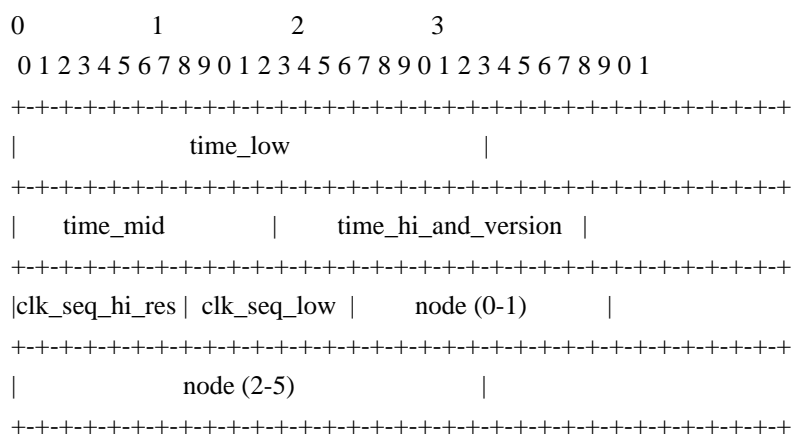
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clock_seq_hi_and_rese unsigned 8 8 The high field of the

| | | | |
|---------------|-------------------------|------------------------------|--------------------------------------|
| rved | bit integer | clock sequence | |
| | | multiplexed with the variant | |
| clock_seq_low | unsigned 8 bit integer | 9 | The low field of the clock sequence |
| node | unsigned 48 bit integer | 10-15 | The spatially unique node identifier |

In the absence of explicit application or presentation protocol specification to the contrary, a UUID is encoded as a 128-bit object, as follows:

The fields are encoded as 16 octets, with the sizes and order of the fields defined above, and with each field encoded with the Most Significant Byte first (known as network byte order). Note that the field names, particularly for multiplexed fields, follow historical practice.



4.1.3. Version

The version number is in the most significant 4 bits of the time stamp (bits 4 through 7 of the time_hi_and_version field).

The following table lists the currently-defined versions for this UUID variant.

| Msb0 | Msb1 | Msb2 | Msb3 | Version | Description |
|------|------|------|------|---------|--|
| 0 | 0 | 0 | 1 | 1 | The time-based version specified in this document. |
| 0 | 0 | 1 | 0 | 2 | DCE Security version, with embedded POSIX UIDs. |

0 0 1 1 3 The name-based version specified in this document that uses MD5 hashing.

0 1 0 0 4 The randomly or pseudo-randomly generated version specified in this document.

0 1 0 1 5 The name-based version specified in this document that uses SHA-1 hashing.

The version is more accurately a sub-type; again, we retain the term for compatibility.

4.1.4. Timestamp

The timestamp is a 60-bit value. For UUID version 1, this is represented by Coordinated Universal Time (UTC) as a count of 100-nanosecond intervals since 00:00:00.00, 15 October 1582 (the date of Gregorian reform to the Christian calendar).

For systems that do not have UTC available, but do have the local time, they may use that instead of UTC, as long as they do so consistently throughout the system. However, this is not recommended since generating the UTC from local time only needs a time zone offset.

For UUID version 3 or 5, the timestamp is a 60-bit value constructed from a name as described in Section 4.3.

For UUID version 4, the timestamp is a randomly or pseudo-randomly generated 60-bit value, as described in Section 4.4.

4.1.5. Clock Sequence

For UUID version 1, the clock sequence is used to help avoid duplicates that could arise when the clock is set backwards in time or if the node ID changes.

If the clock is set backwards, or might have been set backwards

(e.g., while the system was powered off), and the UUID generator can not be sure that no UUIDs were generated with timestamps larger than the value to which the clock was set, then the clock sequence has to be changed. If the previous value of the clock sequence is known, it can just be incremented; otherwise it should be set to a random or high-quality pseudo-random value.

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Similarly, if the node ID changes (e.g., because a network card has been moved between machines), setting the clock sequence to a random number minimizes the probability of a duplicate due to slight differences in the clock settings of the machines. If the value of clock sequence associated with the changed node ID were known, then the clock sequence could just be incremented, but that is unlikely.

The clock sequence **MUST** be originally (i.e., once in the lifetime of a system) initialized to a random number to minimize the correlation across systems. This provides maximum protection against node identifiers that may move or switch from system to system rapidly. The initial value **MUST NOT** be correlated to the node identifier.

For UUID version 3 or 5, the clock sequence is a 14-bit value constructed from a name as described in Section 4.3.

For UUID version 4, clock sequence is a randomly or pseudo-randomly generated 14-bit value as described in Section 4.4.

4.1.6. Node

For UUID version 1, the node field consists of an IEEE 802 MAC address, usually the host address. For systems with multiple IEEE 802 addresses, any available one can be used. The lowest addressed octet (octet number 10) contains the global/local bit and the unicast/multicast bit, and is the first octet of the address transmitted on an 802.3 LAN.

For systems with no IEEE address, a randomly or pseudo-randomly generated value may be used; see Section 4.5. The multicast bit must be set in such addresses, in order that they will never conflict with addresses obtained from network cards.

For UUID version 3 or 5, the node field is a 48-bit value constructed from a name as described in Section 4.3.

For UUID version 4, the node field is a randomly or pseudo-randomly generated 48-bit value as described in Section 4.4.

4.1.7. Nil UUID

The nil UUID is special form of UUID that is specified to have all 128 bits set to zero.

4.2. Algorithms for Creating a Time-Based UUID

Various aspects of the algorithm for creating a version 1 UUID are discussed in the following sections.

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4.2.1. Basic Algorithm

The following algorithm is simple, correct, and inefficient:

- o Obtain a system-wide global lock
- o From a system-wide shared stable store (e.g., a file), read the UUID generator state: the values of the timestamp, clock sequence, and node ID used to generate the last UUID.
- o Get the current time as a 60-bit count of 100-nanosecond intervals since 00:00:00.00, 15 October 1582.
- o Get the current node ID.
- o If the state was unavailable (e.g., non-existent or corrupted), or the saved node ID is different than the current node ID, generate a random clock sequence value.
- o If the state was available, but the saved timestamp is later than the current timestamp, increment the clock sequence value.
- o Save the state (current timestamp, clock sequence, and node ID) back to the stable store.

- o Release the global lock.
- o Format a UUID from the current timestamp, clock sequence, and node ID values according to the steps in Section 4.2.2.

If UUIDs do not need to be frequently generated, the above algorithm may be perfectly adequate. For higher performance requirements, however, issues with the basic algorithm include:

- o Reading the state from stable storage each time is inefficient.
- o The resolution of the system clock may not be 100-nanoseconds.
- o Writing the state to stable storage each time is inefficient.
- o Sharing the state across process boundaries may be inefficient.

Each of these issues can be addressed in a modular fashion by local improvements in the functions that read and write the state and read the clock. We address each of them in turn in the following sections.

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4.2.1.1. Reading Stable Storage

The state only needs to be read from stable storage once at boot time, if it is read into a system-wide shared volatile store (and updated whenever the stable store is updated).

If an implementation does not have any stable store available, then it can always say that the values were unavailable. This is the least desirable implementation because it will increase the frequency of creation of new clock sequence numbers, which increases the probability of duplicates.

If the node ID can never change (e.g., the net card is inseparable from the system), or if any change also reinitializes the clock sequence to a random value, then instead of keeping it in stable store, the current node ID may be returned.

4.2.1.2. System Clock Resolution

The timestamp is generated from the system time, whose resolution may be less than the resolution of the UUID timestamp.

If UUIDs do not need to be frequently generated, the timestamp can simply be the system time multiplied by the number of 100-nanosecond intervals per system time interval.

If a system overruns the generator by requesting too many UUIDs within a single system time interval, the UUID service **MUST** either return an error, or stall the UUID generator until the system clock catches up.

A high resolution timestamp can be simulated by keeping a count of the number of UUIDs that have been generated with the same value of the system time, and using it to construct the low order bits of the timestamp. The count will range between zero and the number of 100-nanosecond intervals per system time interval.

Note: If the processors overrun the UUID generation frequently, additional node identifiers can be allocated to the system, which will permit higher speed allocation by making multiple UUIDs potentially available for each time stamp value.

4.2.1.3. Writing Stable Storage

The state does not always need to be written to stable store every time a UUID is generated. The timestamp in the stable store can be periodically set to a value larger than any yet used in a UUID. As long as the generated UUIDs have timestamps less than that value, and

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the clock sequence and node ID remain unchanged, only the shared volatile copy of the state needs to be updated. Furthermore, if the timestamp value in stable store is in the future by less than the typical time it takes the system to reboot, a crash will not cause a reinitialization of the clock sequence.

4.2.1.4. Sharing State Across Processes

If it is too expensive to access shared state each time a UUID is

generated, then the system-wide generator can be implemented to allocate a block of time stamps each time it is called; a per-process generator can allocate from that block until it is exhausted.

4.2.2. Generation Details

Version 1 UUIDs are generated according to the following algorithm:

- o Determine the values for the UTC-based timestamp and clock sequence to be used in the UUID, as described in Section 4.2.1.
- o For the purposes of this algorithm, consider the timestamp to be a 60-bit unsigned integer and the clock sequence to be a 14-bit unsigned integer. Sequentially number the bits in a field, starting with zero for the least significant bit.
- o Set the `time_low` field equal to the least significant 32 bits (bits zero through 31) of the timestamp in the same order of significance.
- o Set the `time_mid` field equal to bits 32 through 47 from the timestamp in the same order of significance.
- o Set the 12 least significant bits (bits zero through 11) of the `time_hi_and_version` field equal to bits 48 through 59 from the timestamp in the same order of significance.
- o Set the four most significant bits (bits 12 through 15) of the `time_hi_and_version` field to the 4-bit version number corresponding to the UUID version being created, as shown in the table above.
- o Set the `clock_seq_low` field to the eight least significant bits (bits zero through 7) of the clock sequence in the same order of significance.

- o Set the 6 least significant bits (bits zero through 5) of the

clock_seq_hi_and_reserved field to the 6 most significant bits (bits 8 through 13) of the clock sequence in the same order of significance.

- o Set the two most significant bits (bits 6 and 7) of the clock_seq_hi_and_reserved to zero and one, respectively.
- o Set the node field to the 48-bit IEEE address in the same order of significance as the address.

4.3. Algorithm for Creating a Name-Based UUID

The version 3 or 5 UUID is meant for generating UUIDs from "names" that are drawn from, and unique within, some "name space". The concept of name and name space should be broadly construed, and not limited to textual names. For example, some name spaces are the domain name system, URLs, ISO Object IDs (OIDs), X.500 Distinguished Names (DNs), and reserved words in a programming language. The mechanisms or conventions used for allocating names and ensuring their uniqueness within their name spaces are beyond the scope of this specification.

The requirements for these types of UUIDs are as follows:

- o The UUIDs generated at different times from the same name in the same namespace MUST be equal.
- o The UUIDs generated from two different names in the same namespace should be different (with very high probability).
- o The UUIDs generated from the same name in two different namespaces should be different with (very high probability).
- o If two UUIDs that were generated from names are equal, then they were generated from the same name in the same namespace (with very high probability).

The algorithm for generating a UUID from a name and a name space are as follows:

- o Allocate a UUID to use as a "name space ID" for all UUIDs generated from names in that name space; see Appendix C for some pre-defined values.
- o Choose either MD5 [4] or SHA-1 [8] as the hash algorithm; If backward compatibility is not an issue, SHA-1 is preferred.

- o Convert the name to a canonical sequence of octets (as defined by the standards or conventions of its name space); put the name space ID in network byte order.
- o Compute the hash of the name space ID concatenated with the name.
- o Set octets zero through 3 of the time_low field to octets zero through 3 of the hash.
- o Set octets zero and one of the time_mid field to octets 4 and 5 of the hash.
- o Set octets zero and one of the time_hi_and_version field to octets 6 and 7 of the hash.
- o Set the four most significant bits (bits 12 through 15) of the time_hi_and_version field to the appropriate 4-bit version number from Section 4.1.3.
- o Set the clock_seq_hi_and_reserved field to octet 8 of the hash.
- o Set the two most significant bits (bits 6 and 7) of the clock_seq_hi_and_reserved to zero and one, respectively.
- o Set the clock_seq_low field to octet 9 of the hash.
- o Set octets zero through five of the node field to octets 10 through 15 of the hash.
- o Convert the resulting UUID to local byte order.

4.4. Algorithms for Creating a UUID from Truly Random or Pseudo-Random Numbers

The version 4 UUID is meant for generating UUIDs from truly-random or pseudo-random numbers.

The algorithm is as follows:

- o Set the two most significant bits (bits 6 and 7) of the clock_seq_hi_and_reserved to zero and one, respectively.

- o Set the four most significant bits (bits 12 through 15) of the `time_hi_and_version` field to the 4-bit version number from Section 4.1.3.
- o Set all the other bits to randomly (or pseudo-randomly) chosen values.

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See Section 4.5 for a discussion on random numbers.

4.5. Node IDs that Do Not Identify the Host

This section describes how to generate a version 1 UUID if an IEEE 802 address is not available, or its use is not desired.

One approach is to contact the IEEE and get a separate block of addresses. At the time of writing, the application could be found at <http://standards.ieee.org/regauth/oui/pilot-ind.html>, and the cost was US\$550.

A better solution is to obtain a 47-bit cryptographic quality random number and use it as the low 47 bits of the node ID, with the least significant bit of the first octet of the node ID set to one. This bit is the unicast/multicast bit, which will never be set in IEEE 802 addresses obtained from network cards. Hence, there can never be a conflict between UUIDs generated by machines with and without network cards. (Recall that the IEEE 802 spec talks about transmission order, which is the opposite of the in-memory representation that is discussed in this document.)

For compatibility with earlier specifications, note that this document uses the unicast/multicast bit, instead of the arguably more correct local/global bit.

Advice on generating cryptographic-quality random numbers can be found in RFC1750 [5].

In addition, items such as the computer's name and the name of the operating system, while not strictly speaking random, will help differentiate the results from those obtained by other systems.

The exact algorithm to generate a node ID using these data is system specific, because both the data available and the functions to obtain them are often very system specific. A generic approach, however, is to accumulate as many sources as possible into a buffer, use a message digest such as MD5 [4] or SHA-1 [8], take an arbitrary 6 bytes from the hash value, and set the multicast bit as described above.

5. Community Considerations

The use of UUIDs is extremely pervasive in computing. They comprise the core identifier infrastructure for many operating systems (Microsoft Windows) and applications (the Mozilla browser) and in many cases, become exposed to the Web in many non-standard ways.

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This specification attempts to standardize that practice as openly as possible and in a way that attempts to benefit the entire Internet.

6. Security Considerations

Do not assume that UUIDs are hard to guess; they should not be used as security capabilities (identifiers whose mere possession grants access), for example. A predictable random number source will exacerbate the situation.

Do not assume that it is easy to determine if a UUID has been slightly transposed in order to redirect a reference to another object. Humans do not have the ability to easily check the integrity of a UUID by simply glancing at it.

Distributed applications generating UUIDs at a variety of hosts must be willing to rely on the random number source at all hosts. If this is not feasible, the namespace variant should be used.

7. Acknowledgments

This document draws heavily on the OSF DCE specification for UUIDs. Ted Ts'o provided helpful comments, especially on the byte ordering section which we mostly plagiarized from a proposed wording he supplied (all errors in that section are our responsibility,

however).

We are also grateful to the careful reading and bit-twiddling of Ralf S. Engelschall, John Larmouth, and Paul Thorpe. Professor Larmouth was also invaluable in achieving coordination with ISO/IEC.

8. Normative References

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Appendix A. Appendix A - Sample Implementation

This implementation consists of 5 files: uuid.h, uuid.c, sysdep.h, sysdep.c and utest.c. The uuid.* files are the system independent implementation of the UUID generation algorithms described above, with all the optimizations described above except efficient state sharing across processes included. The code has been tested on Linux (Red Hat 4.0) with GCC (2.7.2), and Windows NT 4.0 with VC++ 5.0. The code assumes 64-bit integer support, which makes it much clearer.

All the following source files should have the following copyright notice included:

copyrt.h

```
/*
** Copyright (c) 1990- 1993, 1996 Open Software Foundation, Inc.
** Copyright (c) 1989 by Hewlett-Packard Company, Palo Alto, Ca. &
** Digital Equipment Corporation, Maynard, Mass.
** Copyright (c) 1998 Microsoft.
** To anyone who acknowledges that this file is provided "AS IS"
** without any express or implied warranty: permission to use, copy,
** modify, and distribute this file for any purpose is hereby
** granted without fee, provided that the above copyright notices and
** this notice appears in all source code copies, and that none of
** the names of Open Software Foundation, Inc., Hewlett-Packard
** Company, Microsoft, or Digital Equipment Corporation be used in
** advertising or publicity pertaining to distribution of the software
** without specific, written prior permission. Neither Open Software
** Foundation, Inc., Hewlett-Packard Company, Microsoft, nor Digital
** Equipment Corporation makes any representations about the
** suitability of this software for any purpose.
*/
```

uuid.h

```
#include "copyrt.h"
#undef uuid_t
typedef struct {
    unsigned32 time_low;
    unsigned16 time_mid;
    unsigned16 time_hi_and_version;
    unsigned8  clock_seq_hi_and_reserved;
    unsigned8  clock_seq_low;
    byte       node[6];
} uuid_t;
```

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```
/* uuid_create -- generate a UUID */
```

```

int uuid_create(uuid_t * uuid);

/* uuid_create_md5_from_name -- create a version 3 (MD5) UUID using a
   "name" from a "name space" */
void uuid_create_md5_from_name(
    uuid_t *uuid,      /* resulting UUID */
    uuid_t nsid,      /* UUID of the namespace */
    void *name,       /* the name from which to generate a UUID */
    int namelen       /* the length of the name */
);

/* uuid_create_sha1_from_name -- create a version 5 (SHA-1) UUID
   using a "name" from a "name space" */
void uuid_create_sha1_from_name(

    uuid_t *uuid,      /* resulting UUID */
    uuid_t nsid,      /* UUID of the namespace */
    void *name,       /* the name from which to generate a UUID */
    int namelen       /* the length of the name */
);

/* uuid_compare -- Compare two UUID's "lexically" and return
   -1  u1 is lexically before u2
   0  u1 is equal to u2
   1  u1 is lexically after u2
   Note that lexical ordering is not temporal ordering!
   */
int uuid_compare(uuid_t *u1, uuid_t *u2);

```

uuid.c

```

#include "copyrt.h"
#include <string.h>
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include "sysdep.h"
#include "uuid.h"

/* various forward declarations */
static int read_state(unsigned16 *clockseq, uuid_time_t *timestamp,
    uuid_node_t *node);
static void write_state(unsigned16 clockseq, uuid_time_t timestamp,
    uuid_node_t node);
static void format_uuid_v1(uuid_t *uuid, unsigned16 clockseq,
    uuid_time_t timestamp, uuid_node_t node);

```

```
static void format_uuid_v3or5(uuid_t *uuid, unsigned char hash[16],
    int v);
static void get_current_time(uuid_time_t *timestamp);
static unsigned16 true_random(void);

/* uuid_create -- generator a UUID */
int uuid_create(uuid_t *uuid)
{
    uuid_time_t timestamp, last_time;
    unsigned16 clockseq;
    uuid_node_t node;
    uuid_node_t last_node;
    int f;

    /* acquire system-wide lock so we're alone */
    LOCK;
    /* get time, node ID, saved state from non-volatile storage */
    get_current_time(&timestamp);
    get_ieee_node_identifier(&node);
    f = read_state(&clockseq, &last_time, &last_node);

    /* if no NV state, or if clock went backwards, or node ID
       changed (e.g., new network card) change clockseq */
    if (!f || memcmp(&node, &last_node, sizeof node))
        clockseq = true_random();
    else if (timestamp < last_time)
        clockseq++;

    /* save the state for next time */
    write_state(clockseq, timestamp, node);

    UNLOCK;

    /* stuff fields into the UUID */
    format_uuid_v1(uuid, clockseq, timestamp, node);
    return 1;
}

/* format_uuid_v1 -- make a UUID from the timestamp, clockseq,
   and node ID */
void format_uuid_v1(uuid_t* uuid, unsigned16 clock_seq,
```

```

        uuid_time_t timestamp, uuid_node_t node)
{
    /* Construct a version 1 uuid with the information we've gathered
       plus a few constants. */
    uuid->time_low = (unsigned long)(timestamp & 0xFFFFFFFF);
    uuid->time_mid = (unsigned short)((timestamp >> 32) & 0xFFFF);
    uuid->time_hi_and_version =

```

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```

        (unsigned short)((timestamp >> 48) & 0x0FFF);
    uuid->time_hi_and_version |= (1 << 12);
    uuid->clock_seq_low = clock_seq & 0xFF;
    uuid->clock_seq_hi_and_reserved = (clock_seq & 0x3F00) >> 8;
    uuid->clock_seq_hi_and_reserved |= 0x80;
    memcpy(&uuid->node, &node, sizeof uuid->node);
}

```

/* data type for UUID generator persistent state */

```

typedef struct {
    uuid_time_t ts;        /* saved timestamp */
    uuid_node_t node;     /* saved node ID */
    unsigned16 cs;       /* saved clock sequence */
} uuid_state;

```

```
static uuid_state st;
```

/* read_state -- read UUID generator state from non-volatile store */

```
int read_state(unsigned16 *clockseq, uuid_time_t *timestamp,
               uuid_node_t *node)
```

```

{
    static int inited = 0;
    FILE *fp;

    /* only need to read state once per boot */
    if (!inited) {
        fp = fopen("state", "rb");
        if (fp == NULL)
            return 0;
        fread(&st, sizeof st, 1, fp);
        fclose(fp);
        inited = 1;
    }
}

```

```

*clockseq = st.cs;
*timestamp = st.ts;
*node = st.node;
return 1;
}

/* write_state -- save UUID generator state back to non-volatile
storage */
void write_state(unsigned16 clockseq, uuid_time_t timestamp,
                uuid_node_t node)
{
    static int inited = 0;
    static uuid_time_t next_save;
    FILE* fp;

```

| | | |
|---------------|----------------------|-----------|
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```

if (!inited) {
    next_save = timestamp;
    inited = 1;
}

/* always save state to volatile shared state */
st.cs = clockseq;
st.ts = timestamp;
st.node = node;
if (timestamp >= next_save) {
    fp = fopen("state", "wb");
    fwrite(&st, sizeof st, 1, fp);
    fclose(fp);
    /* schedule next save for 10 seconds from now */
    next_save = timestamp + (10 * 10 * 1000 * 1000);
}
}

/* get-current_time -- get time as 60-bit 100ns ticks since UUID epoch.
Compensate for the fact that real clock resolution is
less than 100ns. */
void get_current_time(uuid_time_t *timestamp)
{
    static int inited = 0;
    static uuid_time_t time_last;

```

```

static unsigned16 uuids_this_tick;
uuid_time_t time_now;

if (!initd) {
    get_system_time(&time_now);
    uuids_this_tick = UUIDS_PER_TICK;
    initd = 1;
}

for ( ; ; ) {
    get_system_time(&time_now);

    /* if clock reading changed since last UUID generated, */
    if (time_last != time_now) {
        /* reset count of uuids gen'd with this clock reading */
        uuids_this_tick = 0;
        time_last = time_now;
        break;
    }
    if (uuids_this_tick < UUIDS_PER_TICK) {
        uuids_this_tick++;
        break;
    }
}

```

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```

        /* going too fast for our clock; spin */
    }
    /* add the count of uuids to low order bits of the clock reading */
    *timestamp = time_now + uuids_this_tick;
}

```

/* true_random -- generate a crypto-quality random number.

This sample doesn't do that. */

static unsigned16 true_random(void)

{

static int initd = 0;

uuid_time_t time_now;

if (!initd) {

get_system_time(&time_now);

time_now = time_now / UUIDS_PER_TICK;

srand((unsigned int)


```

        (((time_now >> 32) ^ time_now) & 0xffffffff);
    initied = 1;
}

return rand();
}

/* uuid_create_md5_from_name -- create a version 3 (MD5) UUID using a
"name" from a "name space" */
void uuid_create_md5_from_name(uuid_t *uuid, uuid_t nsid, void *name,
                               int namelen)
{
    MD5_CTX c;
    unsigned char hash[16];
    uuid_t net_nsid;

    /* put name space ID in network byte order so it hashes the same
       no matter what endian machine we're on */
    net_nsid = nsid;
    net_nsid.time_low = htonl(net_nsid.time_low);
    net_nsid.time_mid = htons(net_nsid.time_mid);
    net_nsid.time_hi_and_version = htons(net_nsid.time_hi_and_version);

    MD5Init(&c);
    MD5Update(&c, &net_nsid, sizeof net_nsid);
    MD5Update(&c, name, namelen);
    MD5Final(hash, &c);

    /* the hash is in network byte order at this point */
    format_uuid_v3or5(uuid, hash, 3);
}

```

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```

void uuid_create_sha1_from_name(uuid_t *uuid, uuid_t nsid, void *name,
                                int namelen)
{
    SHA_CTX c;
    unsigned char hash[20];
    uuid_t net_nsid;

    /* put name space ID in network byte order so it hashes the same
       no matter what endian machine we're on */

```

```

net_nsid = nsid;
net_nsid.time_low = htonl(net_nsid.time_low);
net_nsid.time_mid = htons(net_nsid.time_mid);
net_nsid.time_hi_and_version = htons(net_nsid.time_hi_and_version);

SHA1_Init(&c);
SHA1_Update(&c, &net_nsid, sizeof net_nsid);
SHA1_Update(&c, name, namelen);
SHA1_Final(hash, &c);

/* the hash is in network byte order at this point */
format_uuid_v3or5(uuid, hash, 5);
}

/* format_uuid_v3or5 -- make a UUID from a (pseudo)random 128-bit
number */
void format_uuid_v3or5(uuid_t *uuid, unsigned char hash[16], int v)
{
/* convert UUID to local byte order */
memcpy(uuid, hash, sizeof *uuid);
uuid->time_low = ntohl(uuid->time_low);
uuid->time_mid = ntohs(uuid->time_mid);
uuid->time_hi_and_version = ntohs(uuid->time_hi_and_version);

/* put in the variant and version bits */
uuid->time_hi_and_version &= 0x0FFF;
uuid->time_hi_and_version |= (v << 12);
uuid->clock_seq_hi_and_reserved &= 0x3F;
uuid->clock_seq_hi_and_reserved |= 0x80;
}

/* uuid_compare -- Compare two UUID's "lexically" and return */
#define CHECK(f1, f2) if (f1 != f2) return f1 < f2 ? -1 : 1;
int uuid_compare(uuid_t *u1, uuid_t *u2)
{
int i;

CHECK(u1->time_low, u2->time_low);
CHECK(u1->time_mid, u2->time_mid);

CHECK(u1->time_hi_and_version, u2->time_hi_and_version);

```

```

CHECK(u1->clock_seq_hi_and_reserved, u2->clock_seq_hi_and_reserved);
CHECK(u1->clock_seq_low, u2->clock_seq_low)
for (i = 0; i < 6; i++) {
    if (u1->node[i] < u2->node[i])
        return -1;
    if (u1->node[i] > u2->node[i])
        return 1;
}
return 0;
}
#endif CHECK

```

sysdep.h

```

#include "copyrt.h"
/* remove the following define if you aren't running WIN32 */
#define WININC 0

#ifdef WININC
#include <windows.h>
#else
#include <sys/types.h>
#include <sys/time.h>
#include <sys/sysinfo.h>
#endif

#include "global.h"
/* change to point to where MD5 .h's live; RFC 1321 has sample
   implementation */
#include "md5.h"

/* set the following to the number of 100ns ticks of the actual
   resolution of your system's clock */
#define UUIDS_PER_TICK 1024

/* Set the following to a calls to get and release a global lock */
#define LOCK
#define UNLOCK

typedef unsigned long   unsigned32;
typedef unsigned short unsigned16;
typedef unsigned char  unsigned8;
typedef unsigned char  byte;

/* Set this to what your compiler uses for 64-bit data type */
#ifdef WININC

```

```
#define unsigned64_t unsigned __int64
#define I64(C) C
#else
#define unsigned64_t unsigned long long
#define I64(C) C##LL
#endif

typedef unsigned64_t uuid_time_t;
typedef struct {
    char nodeID[6];
} uuid_node_t;

void get_ieee_node_identifier(uuid_node_t *node);
void get_system_time(uuid_time_t *uuid_time);
void get_random_info(char seed[16]);

sysdep.c

#include "copyrt.h"
#include <stdio.h>
#include "sysdep.h"

/* system dependent call to get IEEE node ID.
   This sample implementation generates a random node ID. */
void get_ieee_node_identifier(uuid_node_t *node)
{
    static inited = 0;
    static uuid_node_t saved_node;
    char seed[16];
    FILE *fp;

    if (!inited) {
        fp = fopen("nodeid", "rb");
        if (fp) {
            fread(&saved_node, sizeof saved_node, 1, fp);
            fclose(fp);
        }
        else {
            get_random_info(seed);
            seed[0] |= 0x01;
        }
    }
}
```

```

memcpy(&saved_node, seed, sizeof saved_node);
fp = fopen("nodeid", "wb");
if (fp) {
    fwrite(&saved_node, sizeof saved_node, 1, fp);
    fclose(fp);
}
}

```

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```

    initied = 1;
}

*node = saved_node;
}

/* system dependent call to get the current system time. Returned as
   100ns ticks since UUID epoch, but resolution may be less than
   100ns. */
#ifdef _WINDOWS_

void get_system_time(uuid_time_t *uuid_time)
{
    ULARGE_INTEGER time;

    /* NT keeps time in FILETIME format which is 100ns ticks since
       Jan 1, 1601. UUIDs use time in 100ns ticks since Oct 15, 1582.
       The difference is 17 Days in Oct + 30 (Nov) + 31 (Dec)
       + 18 years and 5 leap days. */
    GetSystemTimeAsFileTime((FILETIME *)&time);
    time.QuadPart +=

        (unsigned __int64) (1000*1000*10)     // seconds
        * (unsigned __int64) (60 * 60 * 24)     // days
        * (unsigned __int64) (17+30+31+365*18+5); // # of days
    *uuid_time = time.QuadPart;
}

/* Sample code, not for use in production; see RFC 1750 */
void get_random_info(char seed[16])
{
    MD5_CTX c;
    struct {

```

```

MEMORYSTATUS m;
SYSTEM_INFO s;
FILETIME t;
LARGE_INTEGER pc;
DWORD tc;
DWORD l;
char hostname[MAX_COMPUTERNAME_LENGTH + 1];
} r;

```

```

MD5Init(&c);
GlobalMemoryStatus(&r.m);
GetSystemInfo(&r.s);
GetSystemTimeAsFileTime(&r.t);
QueryPerformanceCounter(&r.pc);
r.tc = GetTickCount();

```

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```

r.l = MAX_COMPUTERNAME_LENGTH + 1;
GetComputerName(r.hostname, &r.l);
MD5Update(&c, &r, sizeof r);
MD5Final(seed, &c);
}

#else

void get_system_time(uuid_time_t *uuid_time)
{
    struct timeval tp;

    gettimeofday(&tp, (struct timezone *)0);

    /* Offset between UUID formatted times and Unix formatted times.
       UUID UTC base time is October 15, 1582.
       Unix base time is January 1, 1970.*/
    *uuid_time = ((unsigned64)tp.tv_sec * 10000000)
        + ((unsigned64)tp.tv_usec * 10)
        + I64(0x01B21DD213814000);
}

/* Sample code, not for use in production; see RFC 1750 */
void get_random_info(char seed[16])
{

```

```

MD5_CTX c;
struct {
    struct sysinfo s;
    struct timeval t;
    char hostname[257];
} r;

MD5Init(&c);
sysinfo(&r.s);
gettimeofday(&r.t, (struct timezone *)0);
gethostname(r.hostname, 256);
MD5Update(&c, &r, sizeof r);
MD5Final(seed, &c);
}

#endif

```

utest.c

```

#include "copyrt.h"
#include "sysdep.h"
#include <stdio.h>
#include "uuid.h"

```

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```

uuid_t NameSpace_DNS = { /* 6ba7b810-9dad-11d1-80b4-00c04fd430c8 */
    0x6ba7b810,
    0x9dad,
    0x11d1,
    0x80, 0xb4, 0x00, 0xc0, 0x4f, 0xd4, 0x30, 0xc8
};

```

```

/* puid -- print a UUID */
void puid(uuid_t u)
{
    int i;

    printf("%8.8x-%4.4x-%4.4x-%2.2x%2.2x-", u.time_low, u.time_mid,
        u.time_hi_and_version, u.clock_seq_hi_and_reserved,
        u.clock_seq_low);
    for (i = 0; i < 6; i++)
        printf("%2.2x", u.node[i]);
}

```

```

    printf("\n");
}

/* Simple driver for UUID generator */
void main(int argc, char **argv)
{
    uuid_t u;
    int f;

    uuid_create(&u);
    printf("uuid_create(): "); puid(u);

    f = uuid_compare(&u, &u);
    printf("uuid_compare(u,u): %d\n", f); /* should be 0 */
    f = uuid_compare(&u, &NameSpace_DNS);
    printf("uuid_compare(u, NameSpace_DNS): %d\n", f); /* s.b. 1 */
    f = uuid_compare(&NameSpace_DNS, &u);
    printf("uuid_compare(NameSpace_DNS, u): %d\n", f); /* s.b. -1 */
    uuid_create_md5_from_name(&u, NameSpace_DNS, "www.widgets.com", 15);
    printf("uuid_create_md5_from_name(): "); puid(u);
}

```

Appendix B. Appendix B - Sample Output of utest

```

uuid_create(): 7d444840-9dc0-11d1-b245-5ffdce74fad2
uuid_compare(u,u): 0
uuid_compare(u, NameSpace_DNS): 1
uuid_compare(NameSpace_DNS, u): -1
uuid_create_md5_from_name(): e902893a-9d22-3c7e-a7b8-d6e313b71d9f

```

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Appendix C. Appendix C - Some Name Space IDs

This appendix lists the name space IDs for some potentially interesting name spaces, as initialized C structures and in the string representation defined above.

```

/* Name string is a fully-qualified domain name */
uuid_t NameSpace_DNS = { /* 6ba7b810-9dad-11d1-80b4-00c04fd430c8 */
    0x6ba7b810,

```



```

    0x9dad,
    0x11d1,
    0x80, 0xb4, 0x00, 0xc0, 0x4f, 0xd4, 0x30, 0xc8
};

/* Name string is a URL */
uuid_t Namespace_URL = { /* 6ba7b811-9dad-11d1-80b4-00c04fd430c8 */
    0x6ba7b811,
    0x9dad,
    0x11d1,
    0x80, 0xb4, 0x00, 0xc0, 0x4f, 0xd4, 0x30, 0xc8
};

/* Name string is an ISO OID */
uuid_t Namespace_OID = { /* 6ba7b812-9dad-11d1-80b4-00c04fd430c8 */
    0x6ba7b812,
    0x9dad,
    0x11d1,
    0x80, 0xb4, 0x00, 0xc0, 0x4f, 0xd4, 0x30, 0xc8
};

/* Name string is an X.500 DN (in DER or a text output format) */
uuid_t Namespace_X500 = { /* 6ba7b814-9dad-11d1-80b4-00c04fd430c8 */
    0x6ba7b814,
    0x9dad,
    0x11d1,
    0x80, 0xb4, 0x00, 0xc0, 0x4f, 0xd4, 0x30, 0xc8
};

```

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Acknowledgement

Funding for the RFC Editor function is currently provided by the Internet Society.

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Found in path(s):

* /opt/cola/permits/1188391903_1628857097.46/0/rfc4122-txt-1-zip/rfc4122.txt

1.3 boost 1.65

1.3.1 Available under license :

```
#!/usr/bin/env python
from subprocess import check_output as run
from datetime import datetime
from itertools import groupby
from operator import itemgetter
import re
import magic

def authors(filename):
    log = run(['git', 'log', '--follow',
              '--date=short', '--format=%aN%x09%ad', filename],
              universal_newlines=True)
    for line in log.splitlines():
        author, date = line.split('\t')
        if author != 'fix-copyright.py':
            yield author, datetime.strptime(date, '%Y-%m-%d')

def new_copyright(filename, previous):
    def f():
        au = list(authors(filename))
        alldates = map(itemgetter(1), au)
        aup = sorted(au + map(lambda a: (a, None), previous), key=itemgetter(0))
        for author, records in groupby(aup, itemgetter(0)):
            dates = filter(None, map(itemgetter(1), records))
            if not dates: dates = alldates
            start = min(dates)
            end = max(dates)
            fmt = '{0}' if start.year == end.year else '{0}-{1}'
            line = 'Copyright ' + fmt.format(start.year, end.year) + ' ' + author
```

```

        key = (start, author)
        yield key, line
    return map(itemgetter(1), sorted(f()))

def fix_copyright(filename):
    # Find copyright block in original file
    prefix = set()
    names = []
    lines = []
    with open(filename, 'r') as f:
        content = list(f)
    for i, line in enumerate(content[:15]):
        m = re.match(r'^(?P<prefix>\W*)(\((c)\)?\s*?copyright\s*(\((c)\)?\s+\d{4}\(\s*-\s*\d{4}\)?\s+(?P<name>.+?)\s*$',
line, re.IGNORECASE)
        if m:
            d = m.groupdict()
            prefix.add(d['prefix'])
            lines.append(i)
            names.append(d['name'].strip())
    if len(prefix) != 1:
        print 'Not found:', filename
        return
    prefix = list(prefix)[0]

    print filename
    new = iter(new_copyright(filename, names))
    with open(filename, 'w') as f:
        for i, line in enumerate(content):
            if i in lines:
                for repl in new:
                    print >>f, prefix + repl
            else:
                print >>f, line,
    pass

def all_files():
    ls = run(['git', 'ls-files'], universal_newlines=True)
    for filename in ls.splitlines():
        if magic.from_file(filename, mime=True).split('/')[0] == 'text':
            yield filename

for f in all_files():
    fix_copyright(f)
    //////////////////////////////////////
    //
    // (C) Copyright Ion Gaztanaga    2006-2014
    // (C) Copyright Microsoft Corporation 2014
    //

```

```
// Distributed under the Boost Software License, Version 1.0.
// (See accompanying file LICENSE_1_0.txt or copy at
//      http://www.boost.org/LICENSE_1_0.txt)
//
// See http://www.boost.org/libs/intrusive for documentation.
//
////////////////////////////////////
```

```
#ifndef BOOST_INTRUSIVE_DETAIL_MPL_HPP
#define BOOST_INTRUSIVE_DETAIL_MPL_HPP
```

```
#ifndef BOOST_CONFIG_HPP
# include <boost/config.hpp>
#endif
```

```
#if defined(BOOST_HAS_PRAGMA_ONCE)
# pragma once
#endif
```

```
#include <boost/intrusive/detail/config_begin.hpp>
#include <boost/move/detail/type_traits.hpp>
#include <cstdint>
```

```
namespace boost {
namespace intrusive {
namespace detail {
```

```
using boost::move_detail::is_same;
using boost::move_detail::add_const;
using boost::move_detail::remove_const;
using boost::move_detail::remove_cv;
using boost::move_detail::remove_reference;
using boost::move_detail::add_reference;
using boost::move_detail::remove_pointer;
using boost::move_detail::add_pointer;
using boost::move_detail::true_type;
using boost::move_detail::false_type;
using boost::move_detail::enable_if_c;
using boost::move_detail::enable_if;
using boost::move_detail::disable_if_c;
using boost::move_detail::disable_if;
using boost::move_detail::is_convertible;
using boost::move_detail::if_c;
using boost::move_detail::if_;
using boost::move_detail::is_const;
using boost::move_detail::identity;
using boost::move_detail::alignment_of;
using boost::move_detail::is_empty;
```

```

using boost::move_detail::addressof;
using boost::move_detail::integral_constant;
using boost::move_detail::enable_if_convertible;
using boost::move_detail::disable_if_convertible;
using boost::move_detail::bool_;
using boost::move_detail::true_;
using boost::move_detail::false_;
using boost::move_detail::yes_type;
using boost::move_detail::no_type;
using boost::move_detail::apply;
using boost::move_detail::eval_if_c;
using boost::move_detail::eval_if;
using boost::move_detail::unvoid_ref;
using boost::move_detail::add_const_if_c;

template<std::size_t S>
struct ls_zeros
{
    static const std::size_t value = (S & std::size_t(1)) ? 0 : (1 + ls_zeros<(S>>1u)>::value);
};

template<>
struct ls_zeros<0>
{
    static const std::size_t value = 0;
};

template<>
struct ls_zeros<1>
{
    static const std::size_t value = 0;
};

// Infrastructure for providing a default type for T::TNAME if absent.
#define BOOST_INTRUSIVE_INSTANTIATE_DEFAULT_TYPE_TMPLT(TNAME) \
    template <typename T, typename DefaultType> \
    struct boost_intrusive_default_type_ ## TNAME \
    { \
        template <typename X> \
        static char test(int, typename X::TNAME*); \
        \
        template <typename X> \
        static int test(...); \
        \
        struct DefaultWrap { typedef DefaultType TNAME; }; \
        \
        static const bool value = (1 == sizeof(test<T>(0, 0))); \
    }

```

```

typedef typename
    ::boost::intrusive::detail::if_c
        <value, T, DefaultWrap>::type::TNAME type;
};
//

#define BOOST_INTRUSIVE_OBTAIN_TYPE_WITH_DEFAULT(INSTANTIATION_NS_PREFIX, T,
TNAME, TIMPL) \
    typename INSTANTIATION_NS_PREFIX
        boost_intrusive_default_type_ ## TNAME< T, TIMPL >::type
//

#define BOOST_INTRUSIVE_INSTANTIATE_EVAL_DEFAULT_TYPE_TMPLT(TNAME)\
template <typename T, typename DefaultType>
struct boost_intrusive_eval_default_type_ ## TNAME
{
    template <typename X>
        static char test(int, typename X::TNAME*);

    template <typename X>
        static int test(...);

    struct DefaultWrap
    { typedef typename DefaultType::type TNAME; };

    static const bool value = (1 == sizeof(test<T>(0, 0)));

    typedef typename
        ::boost::intrusive::detail::eval_if_c
            < value
                , ::boost::intrusive::detail::identity<T>
                , ::boost::intrusive::detail::identity<DefaultWrap>
            >::type::TNAME type;
};
//

#define BOOST_INTRUSIVE_OBTAIN_TYPE_WITH_EVAL_DEFAULT(INSTANTIATION_NS_PREFIX, T,
TNAME, TIMPL) \
    typename INSTANTIATION_NS_PREFIX
        boost_intrusive_eval_default_type_ ## TNAME< T, TIMPL >::type
//

#define BOOST_INTRUSIVE_INTERNAL_STATIC_BOOL_IS_TRUE(TRAIT_PREFIX,
TYPEDEF_TO_FIND) \
template <class T>\
struct TRAIT_PREFIX##_bool\
{\
    template<bool Add>\

```



```

struct two_or_three {yes_type _[2 + Add];}\
template <class U> static yes_type test(...);\
template <class U> static two_or_three<U::TYPEDEF_TO_FIND> test (int);\
static const std::size_t value = sizeof(test<T>(0));\
};\
\
template <class T>\
struct TRAITS_PREFIX##_bool_is_true\
{\
static const bool value = TRAITS_PREFIX##_bool<T>::value > sizeof(yes_type)*2;\
};\
//

#define BOOST_INTRUSIVE_HAS_STATIC_MEMBER_FUNC_SIGNATURE(TRAITS_NAME,\
FUNC_NAME) \
template <typename U, typename Signature> \
class TRAITS_NAME \
{ \
private: \
template<Signature> struct helper;\
template<typename T> \
static ::boost::intrusive::detail::yes_type test(helper<&T::FUNC_NAME>*); \
template<typename T> static ::boost::intrusive::detail::no_type test(...); \
public: \
static const bool value = sizeof(test<U>(0)) == sizeof(::boost::intrusive::detail::yes_type); \
}; \
//

#define BOOST_INTRUSIVE_HAS_MEMBER_FUNC_CALLED(TRAITS_NAME, FUNC_NAME) \
template <typename Type> \
struct TRAITS_NAME \
{ \
struct BaseMixin \
{ \
void FUNC_NAME(); \
}; \
struct Base : public Type, public BaseMixin { Base(); }; \
template <typename T, T t> class Helper{}; \
template <typename U> \
static ::boost::intrusive::detail::no_type test(U*, Helper<void (BaseMixin::*)(), &U::FUNC_NAME>* = 0); \
static ::boost::intrusive::detail::yes_type test(...); \
static const bool value = sizeof(::boost::intrusive::detail::yes_type) == sizeof(test((Base*)(0))); \
}; \
//

#define BOOST_INTRUSIVE_HAS_MEMBER_FUNC_CALLED_IGNORE_SIGNATURE(TRAITS_NAME,\
FUNC_NAME) \
BOOST_INTRUSIVE_HAS_MEMBER_FUNC_CALLED(TRAITS_NAME##_ignore_signature, FUNC_NAME)

```

```

\
\
template <typename Type, class> \
struct TRAITS_NAME \
: public TRAITS_NAME##_ignore_signature<Type> \
{ };\
//

} //namespace detail
} //namespace intrusive
} //namespace boost

#include <boost/intrusive/detail/config_end.hpp>

#endif //BOOST_INTRUSIVE_DETAIL_MPL_HPP
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<bridgehead renderas="sect2">Boost Date-Time Library License</bridgehead>
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format="GIF"
fileref="../../boost.png"
alt="C++ Boost" />
</ulink>-->
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<!--hr / -->

<ulink url="mailto:jeff@crystalclearsoftware.com">Jeff Garland</ulink>
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</section>

This is an attempt to acknowledge early contributions to the garbage collector. Later contributions should instead be mentioned in README.changes.

HISTORY -

Early versions of this collector were developed as a part of research projects supported in part by the National Science Foundation and the Defense Advance Research Projects Agency.

The garbage collector originated as part of the run-time system for the Russell programming language implementation. The first version of the garbage collector was written primarily by Al Demers. It was then refined and mostly rewritten, primarily by Hans-J. Boehm, at Cornell U., the University of Washington, Rice University (where it was first used for C and assembly code), Xerox PARC, SGI, and HP Labs. However, significant contributions have also been made by many others.

Some other contributors:

More recent contributors are mentioned in the modification history in README.changes. My apologies for any omissions.

The SPARC specific code was originally contributed by Mark Weiser. The Encore Multimax modifications were supplied by Kevin Kenny (kenny@m.cs.uiuc.edu). The adaptation to the IBM PC/RT is largely due to Vernon Lee, on machines made available to Rice by IBM.

Much of the HP specific code and a number of good suggestions for improving the generic code are due to Walter Underwood.

Robert Brazile (brazile@diamond.bbn.com) originally supplied the ULTRIX code. Al Dosser (dosser@src.dec.com) and Regis Cridlig (Regis.Cridlig@cl.cam.ac.uk) subsequently provided updates and information on variation between ULTRIX systems. Parag Patel (parag@netcom.com) supplied the A/UX code.

Jesper Peterson(jep@mtiame.mtia.oz.au), Michel Schinz, and Martin Tauchmann (martintauchmann@bigfoot.com) supplied the Amiga port.

Thomas Funke (thf@zelator.in-berlin.de(?)) and
Brian D. Carlstrom (bdc@clark.lcs.mit.edu) supplied the NeXT ports.
Douglas Steel (doug@wg.icl.co.uk) provided ICL DRS6000 code.
Bill Janssen (janssen@parc.xerox.com) supplied the SunOS dynamic loader
specific code. Manuel Serrano (serrano@cornas.inria.fr) supplied linux and
Sony News specific code. Al Dosser provided Alpha/OSF/1 code. He and
Dave Detlefs (detlefs@src.dec.com) also provided several generic bug fixes.
Alistair G. Crooks (agc@uts.amdahl.com) supplied the NetBSD and 386BSD ports.
Jeffrey Hsu (hsu@soda.berkeley.edu) provided the FreeBSD port.
Brent Benson (brent@jade.ssd.csd.harris.com) ported the collector to
a Motorola 88K processor running CX/UX (Harris NightHawk).
Ari Huttunen (Ari.Huttunen@hut.fi) generalized the OS/2 port to
nonIBM development environments (a nontrivial task).
Patrick Beard (beard@cs.ucdavis.edu) provided the initial MacOS port.
David Chase, then at Olivetti Research, suggested several improvements.
Scott Schwartz (schwartz@groucho.cse.psu.edu) supplied some of the
code to save and print call stacks for leak detection on a SPARC.
Jesse Hull and John Ellis supplied the C++ interface code.
Zhong Shao performed much of the experimentation that led to the
current typed allocation facility. (His dynamic type inference code hasn't
made it into the released version of the collector, yet.)
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[section:mpl MPL Interoperability]

All the value based traits in this library conform to MPL's requirements for an [[@../.../libs/mpl/doc/refmanual/integral-constant.html](#) Integral Constant type].

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[endsect]
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<link rel="home" href="../../index.html" title="Chapter 1: Boost.TypeTraits">

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<link rel="prev" href="intrinsic.html" title="Support for Compiler Intrinsics">

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<td align="center">Home</td>

<td align="center">Libraries</td>

<td align="center">People</td>

<td align="center">FAQ</td>

<td align="center">More</td>

</tr></table>

<hr>

<div class="spirit-nav">

<a accesskey="h"

href="../../index.html"><a accesskey="n"

href="examples.html">

</div>

<div class="section">

<div class="titlepage"><div><div><h2 class="title" style="clear: both">

MPL

Interoperability

</h2></div></div></div>

<p>

All the value based traits in this library conform to MPL's requirements for

an Integral

```

    Constant type</a>.
</p>
<p>
    Please note that these types no longer inherit from <code class="computeroutput"><span
class="identifier">mpl</span><span class="special">::</span><span class="identifier">>true_</span></code> or
    <code class="computeroutput"><span class="identifier">mpl</span><span class="special">::</span><span
class="identifier">>false_</span></code> etc, and the library will no longer
    implicitly include any MPL header. However there is an implicit conversion
    from <code class="computeroutput"><span class="identifier">integral_constant</span></code> to the
    corresponding MPL types, therefore tag-dispatching that uses MPL types in function
    overloads will still work as before.
</p>
</div>
<table xmlns:rev="http://www.cs.rpi.edu/~gregod/boost/tools/doc/revision" width="100%"><tr>
<td align="left"></td>
<td align="right"><div class="copyright-footer">Copyright &#169; 2000, 2011 Adobe Systems Inc, David
Abrahams,
    Frederic Bron, Steve Cleary, Beman Dawes, Aleksey Gurtovoy, Howard Hinnant,
    Jesse Jones, Mat Marcus, Itay Maman, John Maddock, Alexander Nasonov, Thorsten
    Ottosen, Roman Perepelitsa, Robert Ramey, Jeremy Siek, Robert Stewart and Steven
    Watanabe<p>
        Distributed under the Boost Software License, Version 1.0. (See accompanying
        file LICENSE_1_0.txt or copy at <a href="http://www.boost.org/LICENSE_1_0.txt"
target="_top">http://www.boost.org/LICENSE_1_0.txt</a>)
    </p>
</div></td>
</tr></table>
<hr>
<div class="spirit-nav">
<a accesskey="p" href="intrinsic.html"></a><a
accesskey="u" href="..index.html"></a><a accesskey="h"
href="..index.html"></a><a accesskey="n"
href="examples.html"></a>
</div>
</body>
</html>
[/
Copyright 2006 - 2010 John Maddock and Paul A. Bristow.
Distributed under the Boost Software License, Version 1.0.
(See accompanying file LICENSE_1_0.txt or copy at
http://www.boost.org/LICENSE_1_0.txt).
]
var group__group_ext_mpl =
[
    [ "integral_c", "structboost_1_1mpl_1_1integral__c.html", null ],
    [ "list", "structboost_1_1mpl_1_1list.html", null ],
    [ "vector", "structboost_1_1mpl_1_1vector.html", null ]
];

```

```

/*
 *
 * Copyright (c) 2003 Dr John Maddock
 * Use, modification and distribution is subject to the
 * Boost Software License, Version 1.0. (See accompanying file
 * LICENSE_1_0.txt or copy at http://www.boost.org/LICENSE_1_0.txt)
 *
 */

#include "licence_info.hpp"
#include "bcp_imp.hpp"
#include "fileview.hpp"
#include <fstream>
#include <iomanip>
#include <cstring>
#include <stdexcept>
#include <boost/lexical_cast.hpp>
#include <boost/filesystem/operations.hpp>
#include <boost/throw_exception.hpp>

//
// split_path is a small helper for outputting a path name,
// complete with a link to that path:
//
struct split_path
{
    const fs::path& root;
    const fs::path& file;
    split_path(const fs::path& r, const fs::path& f)
        : root(r), file(f){}
private:
    split_path& operator=(const split_path&);
};

std::ostream& operator << (std::ostream& os, const split_path& p)
{
    os << "<a href=\"" << (p.root / p.file).string() << "\">" << p.file.string() << "</a>";
    return os;
}

std::string make_link_target(const std::string& s)
{
    // convert an arbitrary string into something suitable
    // for an <a> name:
    std::string result;
    for(unsigned i = 0; i < s.size(); ++i)
    {
        result.append(1, static_cast<std::string::value_type>(std::isalnum(s[i]) ? s[i] : '_'));
    }
}

```

```

    }
    return result;
}

void bcp_implementation::output_license_info()
{
    std::pair<const license_info*, int> licenses = get_licenses();

    std::map<int, license_data>::const_iterator i, j;
    i = m_license_data.begin();
    j = m_license_data.end();

    std::ofstream os(m_dest_path.string().c_str());
    if(!os)
    {
        std::string msg("Error opening ");
        msg += m_dest_path.string();
        msg += " for output.";
        std::runtime_error e(msg);
        boost::throw_exception(e);
    }
    os <<
        "<!DOCTYPE HTML PUBLIC \"-//W3C//DTD HTML 4.0 Transitional//EN\">\n"
        "<html>\n"
        "<head>\n"
        "<title>Boost Licence Dependency Information";
    if(m_module_list.size() == 1)
    {
        os << " for " << *(m_module_list.begin());
    }
    os <<
        "</title>\n"
        "</head>\n"
        "<body>\n"
        "<H1>Boost Licence Dependency Information";
    if(m_module_list.size() == 1)
    {
        os << " for " << *(m_module_list.begin());
    }
    os <<
        "</H1>\n"
        "<H2>Contents</h2>\n"
        "<pre><a href=\"#input\">Input Information</a>\n";
    if(!m_bsl_summary_mode)
        os << "<a href=\"#summary\">Licence Summary</a>\n";
    os << "<a href=\"#details\">Licence Details</a>\n";
}

```

```

while(i != j)
{
    // title:
    os << " <A href="#" << make_link_target(licenses.first[i->first].license_name)
        << "\>" << licenses.first[i->first].license_name << "</a>\n";
    ++i;
}

os << "<a href=\"#files\">Files with no recognised license</a>\n"
    "<a href=\"#authors\">Files with no recognised copyright holder</a>\n";
if(!m_bsl_summary_mode)
{
    os <<
        "Moving to the Boost Software License...\n"
        " <a href=\"#bsl-converted\">Files that can be automatically converted to the Boost Software License</a>\n"
        " <a href=\"#to-bsl\">Files that can be manually converted to the Boost Software License</a>\n"
        " <a href=\"#not-to-bsl\">Files that can <b>NOT</b> be moved to the Boost Software License</a>\n"
        " <a href=\"#need-bsl-authors\">Authors we need to move to the Boost Software License</a>\n"
        "<a href=\"#copyright\">Copyright Holder Information</a>\n";
}
os <<
    "<a href=\"#depend\">File Dependency Information</a>\n"
    "</pre>";

//
// input Information:
//
os << "<a name=\"input\"></a><h2>Input Information</h2>\n";
if(m_scan_mode)
    os << "<P>The following files were scanned for boost dependencies:<BR>";
else
    os << "<P>The following Boost modules were checked:<BR>";

std::list<std::string>::const_iterator si = m_module_list.begin();
std::list<std::string>::const_iterator sj = m_module_list.end();
while(si != sj)
{
    os << *si << "<BR>";
    ++si;
}
os << "</p><p>The Boost path was: <code>" << m_boost_path.string() << "</code></P>";
//
// extract the boost version number from the boost directory tree,
// not from this app (which may have been built from a previous
// version):
//
fileview version_file(m_boost_path / "boost/version.hpp");
static const boost::regex version_regex(

```



```

    "^[:blank:]]*#[[:blank:]]*define[:blank:]]+BOOST_VERSION[:blank:]]+(\d+)");
boost::cmatch what;
if(boost::regex_search(version_file.begin(), version_file.end(), what, version_regex))
{
    int version = boost::lexical_cast<int>(what.str(1));
    os << "<p>The Boost version is: " << version / 100000 << "." << version / 100 % 1000 << "." << version % 100
<< "</P>\n";
}

//
// output each license:
//
i = m_license_data.begin();
j = m_license_data.end();
if(!m_bsl_summary_mode)
{
    //
    // start with the summary:
    //
    os << "<a name=\"summary\"></a><h2>Licence Summary</h2>\n";
    while(i != j)
    {
        // title:
        os <<
            "<H3>" << licenses.first[i->first].license_name << "</H3>\n";
        // license text:
        os << "<BLOCKQUOTE>" << licenses.first[i->first].license_text << "</BLOCKQUOTE>";
        // Copyright holders:
        os << "<P>This license is used by " << i->second.authors.size()
            << " authors and " << i->second.files.size()
            << " files <a href=\"#\" << make_link_target(licenses.first[i->first].license_name) << "\">(see details)</a>";
        os << "</P></BLOCKQUOTE>\n";
        ++i;
    }
}
//
// and now the details:
//
i = m_license_data.begin();
j = m_license_data.end();
int license_index = 0;
os << "<a name=\"details\"></a><h2>Licence Details</h2>\n";
while(i != j)
{
    // title:
    os <<
        "<H3><A name=\"" << make_link_target(licenses.first[i->first].license_name)
        << "\"></a>" << licenses.first[i->first].license_name << "</H3>\n";
}

```

```

// license text:
os << "<BLOCKQUOTE>" << licenses.first[i->first].license_text << "</BLOCKQUOTE>";
if(!m_bsl_summary_mode || (license_index >= 3))
{
    // Copyright holders:
    os << "<P>This license is used by the following " << i->second.authors.size() << " copyright
holders:</P>\n<BLOCKQUOTE><P>";
    std::set<std::string>::const_iterator x, y;
    x = i->second.authors.begin();
    y = i->second.authors.end();
    while(x != y)
    {
        os << *x << "<BR>\n";
        ++x;
    }
    os << "</P></BLOCKQUOTE>\n";
    // Files using this license:
    os << "<P>This license applies to the following " << i->second.files.size() << "
files:</P>\n<BLOCKQUOTE><P>";
    std::set<fs::path, path_less>::const_iterator m, n;
    m = i->second.files.begin();
    n = i->second.files.end();
    while(m != n)
    {
        os << split_path(m_boost_path, *m) << "<br>\n";
        ++m;
    }
    os << "</P></BLOCKQUOTE>\n";
}
else
{
    os << "<P>This license is used by " << i->second.authors.size() << " authors (list omitted for brevity).</P>\n";
    os << "<P>This license applies to " << i->second.files.size() << " files (list omitted for brevity).</P>\n";
}
++license_index;
++i;
}
//
// Output list of files not found to be under license control:
//
os << "<h2><a name=\"files\"></a>Files With No Recognisable Licence</h2>\n"
    "<P>The following " << m_unknown_licenses.size() << " files had no recognisable license
information:</P><BLOCKQUOTE><P>\n";
std::set<fs::path, path_less>::const_iterator i2, j2;
i2 = m_unknown_licenses.begin();
j2 = m_unknown_licenses.end();
while(i2 != j2)
{

```

```

    os << split_path(m_boost_path, *i2) << "<br>\n";
    ++i2;
}
os << "</p></BLOCKQUOTE>";
//
// Output list of files with no found copyright holder:
//
os << "<h2><a name=\"authors\"></a>Files With No Recognisable Copyright Holder</h2>\n"
    "<P>The following " << m_unknown_authors.size() << " files had no recognisable copyright
holder:</P>\n<BLOCKQUOTE><P>";
i2 = m_unknown_authors.begin();
j2 = m_unknown_authors.end();
while(i2 != j2)
{
    os << split_path(m_boost_path, *i2) << "<br>\n";
    ++i2;
}
os << "</p></BLOCKQUOTE>";
if(!m_bsl_summary_mode)
{
    //
    // Output list of files that have been moved over to the Boost
    // Software License, along with enough information for human
    // verification.
    //
    os << "<h2><a name=\"bsl-converted\"></a>Files that can be automatically converted to the Boost Software
License</h2>\n"
        << "<P>The following " << m_converted_to_bsl.size() << " files can be automatically converted to the Boost
Software License, but require manual verification before they can be committed to CVS:</P>\n";
    if (!m_converted_to_bsl.empty())
    {
        typedef std::map<fs::path, std::pair<std::string, std::string>, path_less>
            ::const_iterator conv_iterator;
        conv_iterator i = m_converted_to_bsl.begin(),
            ie = m_converted_to_bsl.end();
        int file_num = 1;
        while (i != ie)
        {
            os << "<P>[" << file_num << "] File: <tt>" << split_path(m_boost_path, i->first)
                << "</tt><br>\n<table border=\"1\">\n <tr>\n <td><pre>"
                << i->second.first << "</pre></td>\n <td><pre>"
                << i->second.second << "</pre></td>\n </tr>\n</table>\n";
            ++i;
            ++file_num;
        }
    }
}
//
// Output list of files that could be moved over to the Boost Software License

```

```

//
os << "<h2><a name=\"to-bsl\"></a>Files that could be converted to the Boost Software License</h2>\n"
"<P>The following " << m_can_migrate_to_bsl.size() << " files could be manually converted to the Boost
Software License, but have not yet been:</P>\n<BLOCKQUOTE><P>";
i2 = m_can_migrate_to_bsl.begin();
j2 = m_can_migrate_to_bsl.end();
while(i2 != j2)
{
os << split_path(m_boost_path, *i2) << "<br>\n";
++i2;
}
os << "</p></BLOCKQUOTE>";
//
// Output list of files that can not be moved over to the Boost Software License
//
os << "<h2><a name=\"not-to-bsl\"></a>Files that can NOT be converted to the Boost Software
License</h2>\n"
"<P>The following " << m_cannot_migrate_to_bsl.size() << " files cannot be converted to the Boost Software
License because we need the permission of more authors:</P>\n<BLOCKQUOTE><P>";
i2 = m_cannot_migrate_to_bsl.begin();
j2 = m_cannot_migrate_to_bsl.end();
while(i2 != j2)
{
os << split_path(m_boost_path, *i2) << "<br>\n";
++i2;
}
os << "</p></BLOCKQUOTE>";
//
// Output list of authors that we need permission for to move to the BSL
//
os << "<h2><a name=\"need-bsl-authors\"></a>Authors we need for the BSL</h2>\n"
"<P>Permission of the following authors is needed before we can convert to the Boost Software License. The
list of authors that have given their permission is contained in <code>more/blanket-
permission.txt</code>.</P>\n<BLOCKQUOTE><P>";
std::copy(m_authors_for_bsl_migration.begin(), m_authors_for_bsl_migration.end(),
std::ostream_iterator<std::string>(os, "<br>\n"));
os << "</p></BLOCKQUOTE>";
//
// output a table of copyright information:
//
os << "<H2><a name=\"copyright\"></a>Copyright Holder Information</H2><table border=\"1\">\n";
std::map<std::string, std::set<fs::path, path_less> >::const_iterator ad, ead;
ad = m_author_data.begin();
ead = m_author_data.end();
while(ad != ead)
{
os << "<tr><td>" << ad->first << "</td><td>";
std::set<fs::path, path_less>::const_iterator fi, efi;

```

```

    fi = ad->second.begin();
    efi = ad->second.end();
    while(fi != efi)
    {
        os << split_path(m_boost_path, *fi) << " ";
        ++fi;
    }
    os << "</td></tr>\n";
    ++ad;
}
os << "</table>\n";
}

//
// output file dependency information:
//
os << "<H2><a name=\"depend\"></a>File Dependency Information</H2><BLOCKQUOTE><pre>\n";
std::map<fs::path, fs::path, path_less>::const_iterator dep, last_dep;
std::set<fs::path, path_less>::const_iterator fi, efi;
fi = m_copy_paths.begin();
efi = m_copy_paths.end();
// if in summary mode, just figure out the "bad" files and print those only:
std::set<fs::path, path_less> bad_paths;
if(m_bsl_summary_mode)
{
    bad_paths.insert(m_unknown_licenses.begin(), m_unknown_licenses.end());
    bad_paths.insert(m_unknown_authors.begin(), m_unknown_authors.end());
    bad_paths.insert(m_can_migrate_to_bsl.begin(), m_can_migrate_to_bsl.end());
    bad_paths.insert(m_cannot_migrate_to_bsl.begin(), m_cannot_migrate_to_bsl.end());
    typedef std::map<fs::path, std::pair<std::string, std::string>, path_less>
        ::const_iterator conv_iterator;
    conv_iterator i = m_converted_to_bsl.begin(),
        ie = m_converted_to_bsl.end();
    while(i != ie)
    {
        bad_paths.insert(i->first);
        ++i;
    }
    fi = bad_paths.begin();
    efi = bad_paths.end();
    os << "<P>For brevity, only files not under the BSL are shown</P>\n";
}
while(fi != efi)
{
    os << split_path(m_boost_path, *fi);
    dep = m_dependencies.find(*fi);
    last_dep = m_dependencies.end();
    std::set<fs::path, path_less> seen_deps;

```

```

if (dep != last_dep)
while(true)
{
os << " -> ";
if(fs::exists(m_boost_path / dep->second))
os << split_path(m_boost_path, dep->second);
else if(fs::exists(dep->second))
os << split_path(fs::path(), dep->second);
else
os << dep->second.string();
if(seen_deps.find(dep->second) != seen_deps.end())
{
os << " <I>(Circular dependency!)</I>";
break; // circular dependency!!!
}
seen_deps.insert(dep->second);
last_dep = dep;
dep = m_dependencies.find(dep->second);
if((dep == m_dependencies.end()) || (0 == compare_paths(dep->second, last_dep->second)))
break;
}
os << "\n";
++fi;
}
os << "</pre></BLOCKQUOTE>\n";

```

```

os << "</body></html>\n";

```

```

if(!os)
{
std::string msg("Error writing to ");
msg += m_dest_path.string();
msg += ".";
std::runtime_error e(msg);
boost::throw_exception(e);
}

```

```

}
[/=====

```

Boost.Geometry (aka GGL, Generic Geometry Library)

Copyright (c) 2007-2013 Barend Gehrels, Amsterdam, the Netherlands.

Copyright (c) 2008-2013 Bruno Lalande, Paris, France.

Copyright (c) 2009-2013 Mateusz Loskot, London, UK.

Use, modification and distribution is subject to the Boost Software License,

Version 1.0. (See accompanying file LICENSE_1_0.txt or copy at

http://www.boost.org/LICENSE_1_0.txt)

```

=====]/
<!--
Copyright Louis Dionne 2013-2017
Distributed under the Boost Software License, Version 1.0.
(See accompanying file LICENSE.md or copy at http://boost.org/LICENSE_1_0.txt)
-->
<!-- boost-no-inspect -->
<!-- HTML header for doxygen 1.8.9.1-->
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
<meta http-equiv="Content-Type" content="text/xhtml;charset=UTF-8"/>
<meta http-equiv="X-UA-Compatible" content="IE=9"/>
<meta name="generator" content="Doxygen 1.8.11"/>
<title>Boost.Hana: Boost.MPL adapters</title>
<link href="tabs.css" rel="stylesheet" type="text/css"/>
<script type="text/javascript" src="jquery.js"></script>
<script type="text/javascript" src="dynsections.js"></script>
<link href="navtree.css" rel="stylesheet" type="text/css"/>
<script type="text/javascript" src="resize.js"></script>
<script type="text/javascript" src="navtreedata.js"></script>
<script type="text/javascript" src="navtree.js"></script>
<script type="text/javascript">
$(document).ready(initResizable);
$(window).load(resizeHeight);
</script>
<link href="search/search.css" rel="stylesheet" type="text/css"/>
<script type="text/javascript" src="search/searchdata.js"></script>
<script type="text/javascript" src="search/search.js"></script>
<script type="text/javascript">
$(document).ready(function() { init_search(); });
</script>
<script type="text/x-mathjax-config">
MathJax.Hub.Config({
  extensions: ["tex2jax.js"],
  jax: ["input/TeX", "output/HTML-CSS"],
});
// Copyright Louis Dionne 2013-2017
// Distributed under the Boost Software License, Version 1.0.
// (See accompanying file LICENSE.md or copy at http://boost.org/LICENSE_1_0.txt)
MathJax.Hub.Config({
  "HTML-CSS": {
    linebreaks: {
      automatic: true,
      width: "75% container"
    }
  }
})

```

```

});
</script><script type="text/javascript" src="https://cdn.mathjax.org/mathjax/latest/MathJax.js"></script>
<link href="doxygen.css" rel="stylesheet" type="text/css" />
<!-- Additional javascript for drawing charts. -->
<script type="text/javascript" src="highcharts.js"></script>
<script type="text/javascript" src="highcharts-data.js"></script>
<script type="text/javascript" src="highcharts-exporting.js"></script>
<script type="text/javascript" src="chart.js"></script>
<script type="text/javascript" src="hana.js"></script>
</head>
<body>
<div id="top"><!-- do not remove this div, it is closed by doxygen! -->
<div id="titlearea">
<table cellspacing="0" cellpadding="0">
<tbody>
<tr style="height: 56px;">
<td id="projectlogo"></td>
<td style="padding-left: 0.5em;">
<div id="projectname">Boost.Hana
&#160;<span id="projectnumber">1.2.0</span>
</div>
<div id="projectbrief">Your standard library for metaprogramming</div>
</td>
<td>
<div id="MSearchBox" class="MSearchBoxInactive">
<span class="left">

<input type="text" id="MSearchField" value="Search" accesskey="S"
onfocus="searchBox.OnSearchFieldFocus(true)"
onblur="searchBox.OnSearchFieldFocus(false)"
onkeyup="searchBox.OnSearchFieldChange(event)"/>
</span><span class="right">
<a id="MSearchClose" href="javascript:searchBox.CloseResultsWindow()"></a>
</span>
</div>
</td>
</tr>
</tbody>
</table>
</div>
<!-- end header part -->
<!-- Generated by Doxygen 1.8.11 -->
<script type="text/javascript">
var searchBox = new SearchBox("searchBox", "search",false,'Search');
</script>

```



```

</div><!-- top -->
<div id="side-nav" class="ui-resizable side-nav-resizable">
  <div id="nav-tree">
    <div id="nav-tree-contents">
      <div id="nav-sync" class="sync"></div>
    </div>
  </div>
  <div id="splitbar" style="-moz-user-select:none;"
    class="ui-resizable-handle">
  </div>
</div>
<script type="text/javascript">
$(document).ready(function(){initNavTree('group__group-ext-mpl.html','');});
</script>
<div id="doc-content">
<!-- window showing the filter options -->
<div id="MSearchSelectWindow"
  onmouseover="return searchBox.OnSearchSelectShow()"
  onmouseout="return searchBox.OnSearchSelectHide()"
  onkeydown="return searchBox.OnSearchSelectKey(event)">
</div>

<!-- iframe showing the search results (closed by default) -->
<div id="MSearchResultsWindow">
<iframe src="javascript:void(0)" frameborder="0"
  name="MSearchResults" id="MSearchResults">
</iframe>
</div>

<div class="header">
  <div class="summary">
<a href="#nested-classes">Classes</a> </div>
  <div class="headertitle">
<div class="title">Boost.MPL adapters<div class="ingroups"><a class="el" href="group__group-
ext.html">External adapters</a></div></div> </div>
</div><!--header-->
<div class="contents">
<a name="details" id="details"></a><h2 class="groupheader">Description</h2>
<p>Adapters for Boost.MPL containers. </p>
<table class="memberdecls">
<tr class="heading"><td colspan="2"><h2 class="groupheader"><a name="nested-classes"></a>
Classes</h2></td></tr>
<tr class="memitem:"><td class="memItemLeft" align="right" valign="top">struct &#160;</td><td
class="memItemRight" valign="bottom"><a class="el"
href="structboost_1_1mpl_1_1integral__c.html">boost::mpl::integral_c< T, v ></a></td></tr>
<tr class="memdesc:"><td class="mdescLeft">&#160;</td><td class="mdescRight">Adapter for IntegralConstants
from the Boost.MPL. <a href="structboost_1_1mpl_1_1integral__c.html#details">More...</a><br /></td></tr>
<tr class="separator:"><td class="memSeparator" colspan="2">&#160;</td></tr>

```

```

<tr class="memitem:"><td class="memItemLeft" align="right" valign="top">struct &#160;</td><td
class="memItemRight" valign="bottom"><a class="el" href="structboost_1_1mpl_1_1list.html">boost::mpl::list< T
></a></td></tr>
<tr class="memdesc:"><td class="mdescLeft">&#160;</td><td class="mdescRight">Adapter for Boost.MPL lists.
<a href="structboost_1_1mpl_1_1list.html#details">More...</a><br /></td></tr>
<tr class="separator:"><td class="memSeparator" colspan="2">&#160;</td></tr>
<tr class="memitem:"><td class="memItemLeft" align="right" valign="top">struct &#160;</td><td
class="memItemRight" valign="bottom"><a class="el"
href="structboost_1_1mpl_1_1vector.html">boost::mpl::vector< T ></a></td></tr>
<tr class="memdesc:"><td class="mdescLeft">&#160;</td><td class="mdescRight">Adapter for Boost.MPL
vectors. <a href="structboost_1_1mpl_1_1vector.html#details">More...</a><br /></td></tr>
<tr class="separator:"><td class="memSeparator" colspan="2">&#160;</td></tr>
</table>
</div><!-- contents -->
</div><!-- doc-content -->
<!--
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-->
<!-- boost-no-inspect -->
<!-- HTML footer for doxygen 1.8.9.1-->
<!-- start footer part -->
<div id="nav-path" class="navpath"><!-- id is needed for treeview function! -->
<ul>
</ul>
</div>
</body>
</html>

```

1.4 libwebp 1.0.3

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1.5 tinythread 1.1

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TinyThread++ v1.1

=====

<http://tinythreadpp.bitsnbites.eu>

About

TinyThread++ is a minimalist, portable, threading library for C++, intended to make it easy to create multi threaded C++ applications.

The library is closely modeled after the C++11 standard, but only a subset is implemented at the moment.

See the documentation in the doc/html directory for more information.

Using TinyThread++

To use TinyThread++ in your own project, just add tinythread.cpp and tinythread.h to your project. In your own code, do:

```
#include <tinythread.h>
using namespace tthread;
```

If you wish to use the `fast_mutex` class, include `fast_mutex.h`:

```
#include <fast_mutex.h>
```

Building the test programs

From the test folder, issue one of the following commands:

Linux, Mac OS X, OpenSolaris etc:

```
make (you may need to use gmake on some systems)
```

Windows/MinGW:

```
mingw32-make
```

Windows/MS Visual Studio:

```
nmake /f Makefile.msvc
```

History

v1.1 - 2012.05.07

- Added `thread::detach()`.

v1.0 - 2010.10.01

- First non-beta release.
- Made `mutex` non-recursive (according to spec), and added `recursive_mutex`.
- General class, code & documentation improvements.
- Added a Makefile for MS Visual Studio.

v0.9 - 2010.08.10

- Added preliminary support for `this_thread::sleep_for()`.

v0.8 - 2010.07.02

- Switched from `CreateThread()` to `_beginthreadex()` for Win32 (should fix tiny memory leaks).
- Better standards compliance and some code cleanup.

v0.7 - 2010.05.17

- Added `this_thread::yield()`.
- Replaced the non-standard `number_of_processors()` function with `thread::hardware_concurrency()`, which is part of the C++0x draft.
- The `thread::id()` class is now more standards compliant (correct namespace and comparison operators).

v0.6 - 2010.04.28

- Added a fast_mutex class (in fast_mutex.h).
- Made the test.cpp application compile under Mac OS X and MinGW/g++ 3.x.

v0.5 - 2010.03.31

- Added the thread_local keyword (support for thread-local storage).
- Added a test application to test the API (test.cpp).
- Improved the Doxygen documentation.

v0.4 - 2010.03.27

- Added thread::get_id() and this_thread::get_id().
- Changed the namespace name from tinythread to tthread.

v0.3 - 2010.03.24

- Fixed a compiler error for fractal.cpp under MS Visual C++.
- Added colors to the fractal generator.

v0.2 - 2010.03.23

- Better C++0x conformance.
- Better documentation.
- New classes:
 - lock_guard
- New member functions:
 - thread::joinable()
 - thread::native_handle()
 - mutex::try_lock()
- Added a multi threaded fractal generator test application.

v0.1 - 2010.03.21

- Initial release.

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Found in path(s):

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1.1/doc/html/tinythread_8h_source.html

* /opt/cola/permits/1188391881_1628857751.35/0/tinythread-1-1-src-1-tar-bz2/TinyThread+++

1.1/doc/html/fast__mutex_8h_source.html

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*/

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```
* /opt/cola/permits/1188391881_1628857751.35/0/tinythread-1-1-src-1-tar-bz2/TinyThread+++1.1/test/hello.cpp
* /opt/cola/permits/1188391881_1628857751.35/0/tinythread-1-1-src-1-tar-bz2/TinyThread+++
1.1/source/tinythread.cpp
* /opt/cola/permits/1188391881_1628857751.35/0/tinythread-1-1-src-1-tar-bz2/TinyThread+++1.1/test/test.cpp
* /opt/cola/permits/1188391881_1628857751.35/0/tinythread-1-1-src-1-tar-bz2/TinyThread+++1.1/test/fractal.cpp
* /opt/cola/permits/1188391881_1628857751.35/0/tinythread-1-1-src-1-tar-bz2/TinyThread+++
1.1/source/tinythread.h
* /opt/cola/permits/1188391881_1628857751.35/0/tinythread-1-1-src-1-tar-bz2/TinyThread+++
1.1/source/fast_mutex.h
```

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```

Found in path(s):

```
* /opt/cola/permits/1188391881_1628857751.35/0/tinythread-1-1-src-1-tar-bz2/TinyThread+++1.1/test/Makefile
* /opt/cola/permits/1188391881_1628857751.35/0/tinythread-1-1-src-1-tar-bz2/TinyThread+++
1.1/test/Makefile.msvc
```

1.6 jansson 2.10

1.6.1 Available under license :

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1.7 picojson 1.3.1

1.7.1 Available under license :

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1.8 libyuv 1722

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1.9 sql-cipher 4.0.0

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1.10 rsamd5c++implementation 1.02

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MD5C.C - RSA Data Security, Inc., MD5 message-digest algorithm
MDDRIVER.C - test driver for MD2, MD4 and MD5

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1.11 libvpx 1.7.0-1367-gac3eccdc2

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1.12 tufao 0.6

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1.13 gettcp6table-from-msdn 2018-08-05

1.13.1 Available under license :

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1.14 tidyhtml 5.7.24

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*

* An almost complete rewrite of MySpell for use by

* the Mozilla project has been developed by David Einstein

* (Deinst@world.std.com). David and I are now

* working on parallel development tracks to help

* our respective projects (Mozilla and OpenOffice.org

* and we will maintain full affix file and dictionary
* file compatibility and work on merging our versions
* of MySpell back into a single tree. David has been
* a significant help in improving MySpell.
*
* Special thanks also go to La'szlo' Ne'meth
* <nemethl@gyorsposta.hu> who is the author of the
* Hungarian dictionary and who developed and contributed
* the code to support compound words in MySpell
* and fixed numerous problems with the encoding
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<signature of Ty Coon>, 1 April 1990
Ty Coon, President of Vice

That's all there is to it!

1.16 libjson 7.6.1

1.16.1 Available under license :

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1.17 opus 1.2.1

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1.18 easywsclient 1.0

1.18.1 Available under license :

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1.19 blowfish++encryptionalgorithm 1.0

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The Blowfish Encryption Algorithm

Block cipher: 64-bit block

Variable key length: 32 bits to 448 bits

Designed by Bruce Schneier

Much faster than DES and IDEA

Unpatented and royalty-free

No license required

1.20 log4cxx 0.10.0

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```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN"
"http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
```

```
<!--
```

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```
--><html xmlns="http://www.w3.org/1999/xhtml">
<head>
  <title>log4cxx - Project License</title>
  <style type="text/css" media="all">
    @import url("./css/maven-base.css");
    @import url("./css/maven-theme.css");
    @import url("./css/site.css");
  </style>
  <link rel="stylesheet" href="./css/print.css" type="text/css" media="print" />
  <meta http-equiv="Content-Type" content="text/html; charset=ISO-8859-1" />
</head>
<body class="composite">
  <div id="banner">
    <a href="http://logging.apache.org/" id="bannerLeft">
```

```

```

```
</a>
```

```
<div class="clear">
```

```
<hr/>
```

```
</div>
```

```
</div>
```

```
<div id="breadcrumbs">
```

```
<div class="xleft">
```

```
Last Published: 2008-03-31
```

```
|
```

```
<a href="http://www.apache.org/" class="externalLink">Apache</a>
```

```
&gt;
```

```
<a href="http://logging.apache.org/" class="externalLink">Logging Services</a>
```

```
&gt;
```

```
log4cxx
```

```
</div>
```

```
<div class="xright">
```

```
</div>
```

```
<div class="clear">
```

```
<hr/>
```

```
</div>
```

```
</div>
```

```
<div id="leftColumn">
```

```
<div id="navcolumn">
```

```
<h5>Get log4cxx</h5>
<ul>

<li class="none">
  <a href="download.html">Download</a>
</li>

<li class="none">
  <a href="changes-report.html">Changes</a>
</li>

<li class="none">
  <strong>License</strong>
</li>
</ul>
<h5>About log4cxx</h5>
<ul>

<li class="none">
  <a href="index.html">What is log4cxx?</a>
</li>

<li class="none">
  <a href="apidocs/index.html">API Documentation</a>
</li>

<li class="none">
  <a href="faq.html">FAQ</a>
</li>
</ul>
<h5>Community</h5>
<ul>

<li class="none">
  <a href="mail-lists.html">Mailing Lists</a>
</li>

<li class="none">
  <a href="issue-tracking.html">Issue Tracking</a>
</li>

<li class="none">
  <a href="http://wiki.apache.org/logging-log4cxx" class="externalLink">Wiki</a>
</li>
</ul>
```

```
<h5>Development</h5>
<ul>

<li class="none">
  <a href="source-repository.html">Repository</a>
</li>

<li class="expanded">
  <a href="">Building</a>
  <ul>

<li class="none">
  <a href="building/autotools.html">autotools</a>
</li>

<li class="none">
  <a href="building/ant.html">Apache Ant</a>
</li>

<li class="none">
  <a href="building/maven.html">Apache Maven 2</a>
</li>

<li class="none">
  <a href="building/vstudio.html">Microsoft Visual Studio</a>
</li>

<li class="none">
  <a href="building/xcode.html">Apple Xcode</a>
</li>
</ul>
</li>
</ul>
<h5>Apache</h5>
<ul>
```

```
<li class="none">
  <a href="http://www.apache.org" class="externalLink">Home</a>
</li>

<li class="none">
  <a href="http://www.apache.org/foundation/sponsorship.html" class="externalLink">Sponsorship</a>
</li>

<li class="none">
  <a href="http://www.apache.org/foundation/thanks.html" class="externalLink">Thanks</a>
</li>

<li class="none">
  <a href="http://www.apachecon.com" class="externalLink">Conferences</a>
</li>
</ul>
<a href="http://maven.apache.org/" title="Built by Maven" class="poweredBy">
  </img>
</a>
```

```
</div>
</div>
<div id="bodyColumn">
  <div id="contentBox">
    <div class="section"><h2>Overview</h2>
    <p>Typically the licenses listed for the project are that of the project itself, and not of dependencies.</p>
  </div>
  <div class="section"><h2>Project License</h2>
  <div class="section"><h3>Apache License, Version 2.0</h3>
  <div class="source"><pre>
    Apache License
    Version 2.0, January 2004
    http://www.apache.org/licenses/
```

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1.22 libjpeg-turbo 1.4.90

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The Independent JPEG Group's JPEG software

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README for release 6b of 27-Mar-1998

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This software is the work of Tom Lane, Philip Gladstone, Jim Boucher, Lee Crocker, Julian Minguillon, Luis Ortiz, George Phillips, Davide Rossi,

Guido Vollbeding, Ge' Weijers, and other members of the Independent JPEG Group.

IJG is not affiliated with the official ISO JPEG standards committee.

DOCUMENTATION ROADMAP

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This file contains the following sections:

OVERVIEW General description of JPEG and the IJG software.
LEGAL ISSUES Copyright, lack of warranty, terms of distribution.
REFERENCES Where to learn more about JPEG.
ARCHIVE LOCATIONS Where to find newer versions of this software.
RELATED SOFTWARE Other stuff you should get.
FILE FORMAT WARS Software *not* to get.
TO DO Plans for future IJG releases.

Other documentation files in the distribution are:

User documentation:

install.doc How to configure and install the IJG software.
usage.doc Usage instructions for cjpeg, djpeg, jpegtran,
 rdjpgcom, and wrjpgcom.
*.1 Unix-style man pages for programs (same info as usage.doc).
wizard.doc Advanced usage instructions for JPEG wizards only.
change.log Version-to-version change highlights.

Programmer and internal documentation:

libjpeg.doc How to use the JPEG library in your own programs.
example.c Sample code for calling the JPEG library.
structure.doc Overview of the JPEG library's internal structure.
filelist.doc Road map of IJG files.
coderrules.doc Coding style rules --- please read if you contribute code.

Please read at least the files install.doc and usage.doc. Useful information can also be found in the JPEG FAQ (Frequently Asked Questions) article. See ARCHIVE LOCATIONS below to find out where to obtain the FAQ article.

If you want to understand how the JPEG code works, we suggest reading one or more of the REFERENCES, then looking at the documentation files (in roughly the order listed) before diving into the code.

OVERVIEW

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This package contains C software to implement JPEG image compression and

decompression. JPEG (pronounced "jay-peg") is a standardized compression method for full-color and gray-scale images. JPEG is intended for compressing "real-world" scenes; line drawings, cartoons and other non-realistic images are not its strong suit. JPEG is lossy, meaning that the output image is not exactly identical to the input image. Hence you must not use JPEG if you have to have identical output bits. However, on typical photographic images, very good compression levels can be obtained with no visible change, and remarkably high compression levels are possible if you can tolerate a low-quality image. For more details, see the references, or just experiment with various compression settings.

This software implements JPEG baseline, extended-sequential, and progressive compression processes. Provision is made for supporting all variants of these processes, although some uncommon parameter settings aren't implemented yet. For legal reasons, we are not distributing code for the arithmetic-coding variants of JPEG; see LEGAL ISSUES. We have made no provision for supporting the hierarchical or lossless processes defined in the standard.

We provide a set of library routines for reading and writing JPEG image files, plus two sample applications "cjpeg" and "djpeg", which use the library to perform conversion between JPEG and some other popular image file formats. The library is intended to be reused in other applications.

In order to support file conversion and viewing software, we have included considerable functionality beyond the bare JPEG coding/decoding capability; for example, the color quantization modules are not strictly part of JPEG decoding, but they are essential for output to colormapped file formats or colormapped displays. These extra functions can be compiled out of the library if not required for a particular application. We have also included "jpegtran", a utility for lossless transcoding between different JPEG processes, and "rdjpgcom" and "wrjpgcom", two simple applications for inserting and extracting textual comments in JFIF files.

The emphasis in designing this software has been on achieving portability and flexibility, while also making it fast enough to be useful. In particular, the software is not intended to be read as a tutorial on JPEG. (See the REFERENCES section for introductory material.) Rather, it is intended to be reliable, portable, industrial-strength code. We do not claim to have achieved that goal in every aspect of the software, but we strive for it.

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The Unix configuration script "configure" was produced with GNU Autoconf. It is copyright by the Free Software Foundation but is freely distributable. The same holds for its supporting scripts (config.guess, config.sub, ltconfig, ltmain.sh). Another support script, install-sh, is copyright by M.I.T. but is also freely distributable.

It appears that the arithmetic coding option of the JPEG spec is covered by patents owned by IBM, AT&T, and Mitsubishi. Hence arithmetic coding cannot legally be used without obtaining one or more licenses. For this reason, support for arithmetic coding has been removed from the free JPEG software. (Since arithmetic coding provides only a marginal gain over the unpatented Huffman mode, it is unlikely that very many implementations will support it.) So far as we are aware, there are no patent restrictions on the remaining code.

The IJG distribution formerly included code to read and write GIF files. To avoid entanglement with the Unisys LZW patent, GIF reading support has been removed altogether, and the GIF writer has been simplified to produce "uncompressed GIFs". This technique does not use the LZW algorithm; the resulting GIF files are larger than usual, but are readable by all standard GIF decoders.

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REFERENCES

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We highly recommend reading one or more of these references before trying to understand the innards of the JPEG software.

The best short technical introduction to the JPEG compression algorithm is Wallace, Gregory K. "The JPEG Still Picture Compression Standard", Communications of the ACM, April 1991 (vol. 34 no. 4), pp. 30-44. (Adjacent articles in that issue discuss MPEG motion picture compression, applications of JPEG, and related topics.) If you don't have the CACM issue handy, a PostScript file containing a revised version of Wallace's article is

available at <ftp://ftp.uu.net/graphics/jpeg/wallace.ps.gz>. The file (actually a preprint for an article that appeared in IEEE Trans. Consumer Electronics) omits the sample images that appeared in CACM, but it includes corrections and some added material. Note: the Wallace article is copyright ACM and IEEE, and it may not be used for commercial purposes.

A somewhat less technical, more leisurely introduction to JPEG can be found in "The Data Compression Book" by Mark Nelson and Jean-loup Gailly, published by M&T Books (New York), 2nd ed. 1996, ISBN 1-55851-434-1. This book provides good explanations and example C code for a multitude of compression methods including JPEG. It is an excellent source if you are comfortable reading C code but don't know much about data compression in general. The book's JPEG sample code is far from industrial-strength, but when you are ready to look at a full implementation, you've got one here...

The best full description of JPEG is the textbook "JPEG Still Image Data Compression Standard" by William B. Pennebaker and Joan L. Mitchell, published by Van Nostrand Reinhold, 1993, ISBN 0-442-01272-1. Price US\$59.95, 638 pp. The book includes the complete text of the ISO JPEG standards (DIS 10918-1 and draft DIS 10918-2). This is by far the most complete exposition of JPEG in existence, and we highly recommend it.

The JPEG standard itself is not available electronically; you must order a paper copy through ISO or ITU. (Unless you feel a need to own a certified official copy, we recommend buying the Pennebaker and Mitchell book instead; it's much cheaper and includes a great deal of useful explanatory material.) In the USA, copies of the standard may be ordered from ANSI Sales at (212) 642-4900, or from Global Engineering Documents at (800) 854-7179. (ANSI doesn't take credit card orders, but Global does.) It's not cheap: as of 1992, ANSI was charging \$95 for Part 1 and \$47 for Part 2, plus 7% shipping/handling. The standard is divided into two parts, Part 1 being the actual specification, while Part 2 covers compliance testing methods. Part 1 is titled "Digital Compression and Coding of Continuous-tone Still Images, Part 1: Requirements and guidelines" and has document numbers ISO/IEC IS 10918-1, ITU-T T.81. Part 2 is titled "Digital Compression and Coding of Continuous-tone Still Images, Part 2: Compliance testing" and has document numbers ISO/IEC IS 10918-2, ITU-T T.83.

Some extensions to the original JPEG standard are defined in JPEG Part 3, a newer ISO standard numbered ISO/IEC IS 10918-3 and ITU-T T.84. IJG currently does not support any Part 3 extensions.

The JPEG standard does not specify all details of an interchangeable file format. For the omitted details we follow the "JFIF" conventions, revision 1.02. A copy of the JFIF spec is available from:

Literature Department
C-Cube Microsystems, Inc.
1778 McCarthy Blvd.

Milpitas, CA 95035

phone (408) 944-6300, fax (408) 944-6314

A PostScript version of this document is available by FTP at <ftp://ftp.uu.net/graphics/jpeg/jfif.ps.gz>. There is also a plain text version at <ftp://ftp.uu.net/graphics/jpeg/jfif.txt.gz>, but it is missing the figures.

The TIFF 6.0 file format specification can be obtained by FTP from <ftp://ftp.sgi.com/graphics/tiff/TIFF6.ps.gz>. The JPEG incorporation scheme found in the TIFF 6.0 spec of 3-June-92 has a number of serious problems. IJG does not recommend use of the TIFF 6.0 design (TIFF Compression tag 6). Instead, we recommend the JPEG design proposed by TIFF Technical Note #2 (Compression tag 7). Copies of this Note can be obtained from <ftp.sgi.com> or from <ftp://ftp.uu.net/graphics/jpeg/>. It is expected that the next revision of the TIFF spec will replace the 6.0 JPEG design with the Note's design. Although IJG's own code does not support TIFF/JPEG, the free libtiff library uses our library to implement TIFF/JPEG per the Note. libtiff is available from <ftp://ftp.sgi.com/graphics/tiff/>.

ARCHIVE LOCATIONS

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The "official" archive site for this software is <ftp.uu.net> (Internet address 192.48.96.9). The most recent released version can always be found there in directory <graphics/jpeg>. This particular version will be archived as <ftp://ftp.uu.net/graphics/jpeg/jpegsrc.v6b.tar.gz>. If you don't have direct Internet access, UUNET's archives are also available via UUCP; contact help@uunet.uu.net for information on retrieving files that way.

Numerous Internet sites maintain copies of the UUNET files. However, only <ftp.uu.net> is guaranteed to have the latest official version.

You can also obtain this software in DOS-compatible "zip" archive format from the SimTel archives (<ftp://ftp.simtel.net/pub/simtelnet/msdos/graphics/>), or on CompuServe in the Graphics Support forum (GO CIS:GRAPHSUP), library 12 "JPEG Tools". Again, these versions may sometimes lag behind the <ftp.uu.net> release.

The JPEG FAQ (Frequently Asked Questions) article is a useful source of general information about JPEG. It is updated constantly and therefore is not included in this distribution. The FAQ is posted every two weeks to Usenet newsgroups <comp.graphics.misc>, <news.answers>, and other groups. It is available on the World Wide Web at <http://www.faqs.org/faqs/jpeg-faq/> and other <news.answers> archive sites, including the official <news.answers> archive at <rtfm.mit.edu>: <ftp://rtfm.mit.edu/pub/usenet/news.answers/jpeg-faq/>. If you don't have Web or FTP access, send e-mail to mail-server@rtfm.mit.edu with body

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send usenet/news.answers/jpeg-faq/part2

RELATED SOFTWARE

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Numerous viewing and image manipulation programs now support JPEG. (Quite a few of them use this library to do so.) The JPEG FAQ described above lists some of the more popular free and shareware viewers, and tells where to obtain them on Internet.

If you are on a Unix machine, we highly recommend Jef Poskanzer's free PBPLUS software, which provides many useful operations on PPM-format image files. In particular, it can convert PPM images to and from a wide range of other formats, thus making cjpeg/djpeg considerably more useful. The latest version is distributed by the NetPBM group, and is available from numerous sites, notably <ftp://wuarchive.wustl.edu/graphics/graphics/packages/NetPBM/>. Unfortunately PBPLUS/NETPBM is not nearly as portable as the IJG software is; you are likely to have difficulty making it work on any non-Unix machine.

A different free JPEG implementation, written by the PVRG group at Stanford, is available from <ftp://havefun.stanford.edu/pub/jpeg/>. This program is designed for research and experimentation rather than production use; it is slower, harder to use, and less portable than the IJG code, but it is easier to read and modify. Also, the PVRG code supports lossless JPEG, which we do not. (On the other hand, it doesn't do progressive JPEG.)

FILE FORMAT WARS

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Some JPEG programs produce files that are not compatible with our library. The root of the problem is that the ISO JPEG committee failed to specify a concrete file format. Some vendors "filled in the blanks" on their own, creating proprietary formats that no one else could read. (For example, none of the early commercial JPEG implementations for the Macintosh were able to exchange compressed files.)

The file format we have adopted is called JFIF (see REFERENCES). This format has been agreed to by a number of major commercial JPEG vendors, and it has become the de facto standard. JFIF is a minimal or "low end" representation. We recommend the use of TIFF/JPEG (TIFF revision 6.0 as modified by TIFF Technical Note #2) for "high end" applications that need to record a lot of additional data about an image. TIFF/JPEG is fairly new and not yet widely supported, unfortunately.

The upcoming JPEG Part 3 standard defines a file format called SPIFF.

SPIFF is interoperable with JFIF, in the sense that most JFIF decoders should be able to read the most common variant of SPIFF. SPIFF has some technical advantages over JFIF, but its major claim to fame is simply that it is an official standard rather than an informal one. At this point it is unclear whether SPIFF will supersede JFIF or whether JFIF will remain the de-facto standard. IJG intends to support SPIFF once the standard is frozen, but we have not decided whether it should become our default output format or not. (In any case, our decoder will remain capable of reading JFIF indefinitely.)

Various proprietary file formats incorporating JPEG compression also exist. We have little or no sympathy for the existence of these formats. Indeed, one of the original reasons for developing this free software was to help force convergence on common, open format standards for JPEG files. Don't use a proprietary file format!

TO DO

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The major thrust for v7 will probably be improvement of visual quality. The current method for scaling the quantization tables is known not to be very good at low Q values. We also intend to investigate block boundary smoothing, "poor man's variable quantization", and other means of improving quality-vs-file-size performance without sacrificing compatibility.

In future versions, we are considering supporting some of the upcoming JPEG Part 3 extensions --- principally, variable quantization and the SPIFF file format.

As always, speeding things up is of great interest.

Please send bug reports, offers of help, etc. to jpeg-info@uunet.uu.net.

1.23 json-cpp 1.8.4

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1.24 uiacomwrapper 1.1.0.14

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1.25 curl 7.64.0

1.25.1 Available under license :

License Mixing

=====

libcurl can be built to use a fair amount of various third party libraries, libraries that are written and provided by other parties that are distributed using their own licenses. Even libcurl itself contains code that may cause problems to some. This document attempts to describe what licenses libcurl and the other libraries use and what possible dilemmas linking and mixing them all can lead to for end users.

I am not a lawyer and this is not legal advice!

One common dilemma is that [GPL](<https://www.gnu.org/licenses/gpl.html>) licensed code is not allowed to be linked with code licensed under the [Original BSD license](<https://spdx.org/licenses/BSD-4-Clause.html>) (with the announcement clause). You may still build your own copies that use them all, but distributing them as binaries would be to violate the GPL license - unless you accompany your license with an [exception](<https://www.gnu.org/licenses/gpl-faq.html#GPLIncompatibleLibs>). This particular problem was addressed when the [Modified BSD license](<https://opensource.org/licenses/BSD-3-Clause>) was created, which does not have the announcement clause that collides with GPL.

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Uses an [MIT style license](<https://curl.haxx.se/docs/copyright.html>) that is very liberal.

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GnuTLS

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[LGPL](<https://www.gnu.org/licenses/lgpl.html>) license. If this is a problem for you, consider using another TLS library. Also note that GnuTLS itself depends on and uses other libs (libgcrypt and libgpg-error) and they too are LGPL- or GPL-licensed.

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libressl

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c-ares

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libssh2

(Used for scp and sftp support) libssh2 uses a Modified BSD-style license.
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1.26 qca 2.2.1

1.26.1 Available under license :

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Version 2.1, February 1999

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1.28 opus 1.3.1

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1.30openh264 2.0.0

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1.31 cyrus-sasl 2.1.0

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1.32 webrtc 72

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 *
 * From: Wilco Dijkstra <Wilco.Dijkstra@ntlworld.com>
 * Date: Fri, Jun 24, 2011 at 3:20 AM
 * Subject: Re: sqrt routine
 * To: Kevin Ma <kma@google.com>
 * Hi Kevin,
 * Thanks for asking. Those routines are public domain (originally posted to
 * comp.sys.arm a long time ago), so you can use them freely for any purpose.
 * Cheers,
 * Wilco
 *
 * ----- Original Message -----
 * From: "Kevin Ma" <kma@google.com>
 * To: <Wilco.Dijkstra@ntlworld.com>
 * Sent: Thursday, June 23, 2011 11:44 PM
 * Subject: Fwd: sqrt routine
 * Hi Wilco,
 * I saw your sqrt routine from several web sites, including
 * http://www.finesse.demon.co.uk/steven/sqrt.html.
```

```
* Just wonder if there's any copyright information with your Successive
* approximation routines, or if I can freely use it for any purpose.
* Thanks.
* Kevin
*/
// sigslot.h: Signal/Slot classes
//
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```

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```
*/
```

```
/*
```

```
* SpanDSP - a series of DSP components for telephony
```

*
* g722_decode.c - The ITU G.722 codec, decode part.
*
* Written by Steve Underwood <steveu@coppice.org>
*
* Copyright (C) 2005 Steve Underwood
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*
* Based in part on a single channel G.722 codec which is:
*
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* Computer Science, Speech Group
* Chengxiang Lu and Alex Hauptmann
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* Memory barrier utilities
*
* Author: Bjorn Roche, XO Audio, LLC
*
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* $Id: pa_ringbuffer.c 1421 2009-11-18 16:09:05Z bjornroche $
* Portable Audio I/O Library
* Ring Buffer utility.
*
* Author: Phil Burk, http://www.softsynth.com
* modified for SMP safety on Mac OS X by Bjorn Roche
* modified for SMP safety on Linux by Leland Lucius
* also, allowed for const where possible
* modified for multiple-byte-sized data elements by Sven Fischer
*
* Note that this is safe only for a single-thread reader and a
* single-thread writer.
*
* This program uses the PortAudio Portable Audio Library.
* For more information see: http://www.portaudio.com
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/*

* SpanDSP - a series of DSP components for telephony

*

* g711.h - In line A-law and u-law conversion routines

*

* Written by Steve Underwood <steveu@coppice.org>

*

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*

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/******

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/*

/* Copyright (c) 1999, Bob Withers - bwit@pobox.com

/*

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/*

/* Enhancements by Stanley Yamane:

```
/**  o reverse lookup table for the decode function
/**  o reserve string buffer space in advance
/**
/*******
```

1.33 protobuf 3.5.2

1.33.1 Available under license :

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1.34 libsrtp 2.2.0

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1.35 stackwalker 34912.0

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1.36 websocketpp 0.8.2

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Bundled Libraries:

***** Base 64 Library (base64/base64.hpp) *****

base64.hpp is a repackaging of the base64.cpp and base64.h files into a single header suitable for use as a header only library. This conversion was done by Peter Thorson (webmaster@zaphoyd.com) in 2012. All modifications to the code are redistributed under the same license as the original, which is listed below.

base64.cpp and base64.h

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***** SHA1 Library (sha1/sha1.hpp) *****

sha1.hpp is a repackaging of the sha1.cpp and sha1.h files from the shallsha1 library (<http://code.google.com/p/smallsha1/>) into a single header suitable for use as a header only library. This conversion was done by Peter Thorson (webmaster@zaphoyd.com) in 2013. All modifications to the code are redistributed under the same license as the original, which is listed below.

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***** MD5 Library (common/md5.hpp) *****

md5.hpp is a reformulation of the md5.h and md5.c code from <http://www.opensource.apple.com/source/cups/cups-59/cups/md5.c> to allow it to function as a component of a header only library. This conversion was done by Peter Thorson (webmaster@zaphoyd.com) in 2012 for the WebSocket++ project. The changes are released under the same license as the original (listed below)

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L. Peter Deutsch
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***** UTF8 Validation logic (utf8_validation.hpp) *****

utf8_validation.hpp is adapted from code originally written by Bjoern Hoehrmann <bjoern@hoehrmann.de>. See <http://bjoern.hoehrmann.de/utf-8/decoder/dfa/> for details.

The original license:

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