NAME

      bulkld_index, create_assoc, create_index, destroy_assoc, destroy_index, find_assoc, print_index − Class
      ss_m Methods for B+Tree Index Operations

SYNOPSIS

```
#include <sm_vas.h>  // includes sm.h (where they are declared)

    /* Logical-ID version */
static rc_t                 create_index(
    const lvid_t&               lvid,
    ndx_t                       ntype,
    store_property_t            property,
    const char*                 key_desc,
    concurrency_t               cc,
    uint                        size_kb_hint,  // hint on final size in KB
    serial_t&                   liid);

    /* Physical-ID version */
static rc_t                 create_index(
    vid_t                       vid,
    ndx_t                       ntype,
    store_property_t            property,
    const char*                 key_desc,
    concurrency_t               cc,
    stid_t&                     stid,     // result
    const serial_t&             logical_id=serial_t::null
    );


    // for backward-compatibility:
    /* Logical ID version */
static rc_t                 create_index(
    const lvid_t&               lvid,
    ndx_t                       ntype,
    store_property_t            property,
    const char*                 key_desc,
    uint                        size_kb_hint,  // hint on final size in KB
    serial_t&                   liid);


    // for backward compatibility:
    /* Physical-ID version */
static rc_t                 create_index(
    vid_t                       vid,
    ndx_t                       ntype,
    store_property_t            property,
    const char*                 key_desc,
    stid_t&                     stid,
    const serial_t&             logical_id=serial_t::null
    );

    /* Logical ID version */
static rc_t                 destroy_index(
    const lvid_t&               lvid,
```

```
                    const serial_t&            liid);

               /* Physical-ID version */
          static rc_t                 destroy_index(
               const stid_t&           iid);


               /* Logical ID version */
          static rc_t                 bulkld_index(
               const lvid_t&           lvid,
               const serial_t&         liid,
               const lvid_t&           s_lvid,
               const serial_t&         s_lfid,
               sm_du_stats_t&          stats);

               /* Physical-ID version */
          static rc_t                 bulkld_index(
               const stid_t&           stid,
               const stid_t&           source,
               sm_du_stats_t&          stats,
               bool                    sort_duplicates = true,
               bool                    lexify_keys = true
               );
               /* Physical-ID, variant of above with multiple input files */
          static rc_t                 bulkld_index(
               const stid_t&           stid,
               int                     nsrcs,
               const stid_t*           source,
               sm_du_stats_t&          stats,
               bool                    sort_duplicates = true,
               bool                    lexify_keys = true
               );


               /* Logical ID version */
          static rc_t                 bulkld_index(
               const lvid_t&           lvid,
               const serial_t&         liid,
               sort_stream_i&          sorted_stream,
               sm_du_stats_t&          stats);

               /* Physical-ID version */
          static rc_t                 bulkld_index(
               const stid_t&           stid,
               sort_stream_i&          sorted_stream,
               sm_du_stats_t&          stats);


               /* Logical ID version */
          static rc_t                 print_index(
               const lvid_t&           lvid,
               const serial_t&         liid);
```

```
    /* Physical-ID version */
static rc_t                 print_index(
    stid_t          stid);


    /* Logical ID version */
static rc_t                 create_assoc(
    const lvid_t&           lvid,
    const serial_t&         liid,
    const vec_t&            key,
    const vec_t&            el);

    /* Physical-ID version */
static rc_t                 create_assoc(
    stid_t                  stid,
    const vec_t&            key,
    const vec_t&            el
    );


    /* Logical ID version */
static rc_t                 destroy_assoc(
    const lvid_t&           lvid,
    const serial_t&         liid,
    const vec_t&            key,
    const vec_t&            el);

    /* Physical-ID version */
static rc_t                 destroy_assoc(
    stid_t                  stid,
    const vec_t&            key,
    const vec_t&            el
    );


    /* Logical ID version */
static rc_t                 destroy_all_assoc(
    const lvid_t&           lvid,
    const serial_t&         liid,
    const vec_t&            key,
    int&                    num_removed);

    /* Physical-ID version */
static rc_t                 destroy_all_assoc(
    stid_t                  stid,
    const vec_t&            key,
    int&                    num_removed
    );


    /* Logical ID version */
static rc_t                 find_assoc(
    const lvid_t&           lvid,
```

```
        const serial_t&             liid,
        const vec_t&                key,
        void*                       el,
        smsize_t&                   elen,      // if you don't want the result,
                                           // make this 0 on input
        bool&                       found);

        /* Physical-ID version */
    static rc_t                     find_assoc(
        stid_t                      stid,
        const vec_t&                key,
        void*                       el,
        smsize_t&                   elen,
        bool&                       found
        );
```

DESCRIPTION

The above class **ss_m** methods manipulate B+tree indexes.

Common Parameters

There are a number of common parameters for these methods:

lvid   Logical volume ID of volume containing an index.

liid   Logical index ID, the serial number of an index. (The Physical-ID versions of these methods take a
        store ID instead of the logical volume and index ID pair.)

key   A vector pointing to the key portion of an index entry.

el   A vector pointing to the element portion of an index entry.

create_index(lvid, ntype, property, key_desc, size_kb_hint, liid)

The **create_index** methods creates a new B+tree index on the volume *lvid,* and returns its serial
number in *liid.* The *ntype* parameter specifies the type of implementation used for the index.
Valid values for the *ntype* parameter are **t_btree,** indicating a B+tree allowing entries with dupli-
cate keys, and **t_uni_btree,** indicating a B+tree only allowing entries with unique keys. The *pro-
perty* parameter specifies whether the index is temporary. See **enum(ssm)** for more information
on **ss_m::store_property_t.**

The *key_desc* parameter is a string describing the the type of the keys to be stored in the index.
The syntax of *key_desc* is as follows:

```
        <key_type_str>      ::= <key_type>* <v_key_type>
        <key_type>          ::= <type> <len>
        <v_key_type>        ::= <type> <var> <len>
        <type>              ::= 'i' | 'u' | 'f' | 'b'
        <var>               ::= '*' | NULL
        <len>               ::= [1-9][0-9]*
```

A <key_type> contains a type ('i' for integer, 'u' for unsigned, 'f' for float, 'b' for binary), and a
length. A <v_key_type>, which is the last part of <key_type_str>, can contain an optional indica-
tor ('*') for variable length field. A <key_type_str> is composed of multiple <key_type>, and a
<v_key_type>; i.e. only the last field can be variable length.

```
                    For example the key_desc "i4f8b*1000" specifies a
                    key that contains:
                        1. a 4 byte integer
                        2. an 8 byte float (double)
                        3. a variable length binary field that could be as long as
                           as a 1000 bytes.
```

The SSM applies a function to the key values, the result of which is a string of bytes that can be lexicographically compared, and yield the correct order. The SSM contains such functions for keys of the following types: signed and unsigned integer keys of length 1, 2, or 4, floating point keys of length 4 or 8. Byte strings keys are not interpreted; they are stored as presented to the SSM.

The *size_kb_hint* parameter allows the caller to give a hint about the final size of the index (in K-bytes). This helps the SM determine where to allocate space for the index. For now, the hint's main purpose is to determine whether the index will fit on one page or on many. A value of 0 should be used if it is known the index will be small or if the final size of the index is unknown. Otherwise a value larger than **ss_m::page_sz/1000 should be used.** Small (one-page) indexes are available only with the logical-ID API. This is because it is possible to re-map the logical ID to a new index when the tree grows to assume a different form.

create_index(lvid, ntype, property, cc, key_desc, size_kb_hint, liid)

This form of **create_index** allows you to associate with the index, a locking protocol other than *t_cc_kvl.* See **enum(ssm)** for more information on **ss_m::concurrency_t.**

See the "ROOT INDEX METHODS" section of **volume(ssm)** for information on how to keep track of the indexes on a volume.

destroy_index(lvid, liid)

The **destroy_index** methods destroys the index and deallocates all space used by it. The space is not available for reuse until the transaction destroying the index commits.

bulkld_index(lvid, liid, s_lvid, s_lfid, stats)

This **bulkld_index** method bulk loads the **empty** index, identified by *lvid* and *liid.* The entries to load must be located, in sorted order, in the file identified by *s_lvid* and *s_lfid.* The header of each record in the file contains the key and the body contains the element (value) associated with the key. Statistics for the newly loaded index are returned in *stats,* specifically in the *btree* field.

bulkld_index(lvid, liid, sorted_stream, stats)

This **bulkld_index** method is identical to the one above except that rather than getting entries from a file, the entries come from *sorted_stream.* **Note:** this method has not been extensively tested and may change in the future. See **sort_stream_i(ssm)** for more information.

print_index(lvid, liid)

The **print_index** method is prints the contents of the index. It is meant to be a debugging tool.

create_assoc(lvid, liid, key, el)

The **create_assoc** method adds a new entry associating *key* with the element (value) *el.*

destroy_assoc(lvid, liid, key, el)

The **destroy_assoc** method destroys the entry associating *key* with the element (value) *el.*

destroy_all_assoc(lvid, liid, key, num_removed)

The **destroy_all_assoc** method destroys all entries with *key* as a key. The number of entries removed is returned in *num_removed.*

find_assoc(lvid, liid, key, el, elen, found)

The **find_assoc** method finds *key* in the index and and writes the associated element (only the first one found) to the address specified by *el.* At most *elen* bytes will be written. If the element is not needed, set *elen* to 0. *Elen* will be set to the length actually written. If *key* is found, then *found* will be set to **true.** A more comprehensive lookup facility, allowing range searches, is available from the class *scan_index_i* described in **scan_index_i(ssm)**

ERRORS

All of the above methods return a **w_rc_t** error code. If an error occurs during a methods that is updating persistent data (the create, destroy, and bulk load methods will update data) then the index could be in an inconsistent state. The caller then has the choice of aborting the transaction or rolling back to the nearest save-point (see **transaction(ssm)**).

See **errors(ssm)** for more information on error handling.

EXAMPLES

To Do.

VERSION

This manual page applies to Version 2.0 of the Shore Storage Manager.

SPONSORSHIP

The Shore project is sponsored by the Advanced Research Project Agency, ARPA order number 018 (formerly 8230), monitored by the U.S. Army Research Laboratory under contract DAAB07-91-C-Q518. Further funding for this work was provided by DARPA through Rome Research Laboratory Contract No. F30602-97-2-0247.

COPYRIGHT

Copyright (c) 1994-1999, Computer Sciences Department, University of Wisconsin -- Madison. All Rights Reserved.

SEE ALSO

scan_index_i(ssm), sort_stream_i(ssm) intro(ssm),