Unified Communication X (UCX)

API Standard

Version 1.18

Contents

1 Preface **1**

1.1 Scope of the Document . . . 1

1.2 Audience . . . 1

1.3 Document Status . . . 1

1.4 License . . . 1

2 Introduction **3**

2.1 Motivation . . . 3

2.2 UCX . . . 3

3 Design **5**

3.1 UCS . . . 5

3.2 UCT . . . 5

3.3 UCP . . . 6

4 Conventions and Notations **7**

4.1 Blocking Behavior . . . 7

4.2 Non-blocking Behavior . . . 7

4.3 Fairness . . . 7

4.4 Interaction with Signal Handler Functions . . . 7

5 Deprecated List **9**

6 Module Documentation **13**

6.1 Unified Communication Protocol (UCP) API . . . 13

6.1.1 Detailed Description . . . 13

6.2 UCP Application Context . . . 14

6.2.1 Detailed Description . . . 15

6.2.2 Data Structure Documentation . . . 15

6.2.2.1 struct ucp_lib_attr . . . 15

6.2.2.2 struct ucp_context_attr . . . 16

6.2.2.3 struct ucp_tag_recv_info . . . 16

6.2.2.4 struct ucp_request_param_t . . . 16

6.2.2.5 union ucp_request_param_t.cb . . . 17
6.2.2.6 union ucp_request_param_t.recv_info . . . 18
6.2.3 Macro Definition Documentation . . . 18
6.2.3.1 UCP_ENTITY_NAME_MAX . . . 18
6.2.4 Typedef Documentation . . . 18
6.2.4.1 ucp_lib_attr_t . . . 18
6.2.4.2 ucp_context_attr_t . . . 18
6.2.4.3 ucp_tag_recv_info_t . . . 18
6.2.4.4 ucp_context_h . . . 19
6.2.4.5 ucp_request_init_callback_t . . . 19
6.2.4.6 ucp_request_cleanup_callback_t . . . 19
6.2.5 Enumeration Type Documentation . . . 19
6.2.5.1 ucp_params_field . . . 19
6.2.5.2 ucp_feature . . . 20
6.2.5.3 ucp_lib_attr_field . . . 20
6.2.5.4 ucp_context_attr_field . . . 20
6.2.6 Function Documentation . . . 21
6.2.6.1 ucp_lib_query() . . . 21
6.2.6.2 ucp_get_version() . . . 21
6.2.6.3 ucp_get_version_string() . . . 21
6.2.6.4 ucp_init() . . . 22
6.2.6.5 ucp_cleanup() . . . 22
6.2.6.6 ucp_context_query() . . . 23
6.2.6.7 ucp_context_print_info() . . . 23
6.3 UCP Worker . . . 24
6.3.1 Detailed Description . . . 26
6.3.2 Data Structure Documentation . . . 27
6.3.2.1 struct ucp_worker_attr . . . 27
6.3.2.2 struct ucp_worker_params . . . 27
6.3.2.3 struct ucp_worker_address_attr . . . 29
6.3.2.4 struct ucp_listener_attr . . . 29
6.3.2.5 struct ucp_conn_request_attr . . . 29
6.3.2.6 struct ucp_listener_params . . . 29
6.3.2.7 struct ucp_am_handler_param . . . 30
6.3.2.8 struct ucp_am_recv_param . . . 31
6.3.2.9 struct ucp_listener_accept_handler . . . 31
6.3.2.10 struct ucp_listener_conn_handler . . . 31
6.3.3 Typedef Documentation . . . 31
6.3.3.1 ucp_worker_attr_t . . . 31
6.3.3.2 ucp_worker_params_t . . . 32

6.3.3.3 ucp_worker_address_attr_t . . . 32
6.3.3.4 ucp_listener_attr_t . . . 32
6.3.3.5 ucp_conn_request_attr_t . . . 32
6.3.3.6 ucp_listener_params_t . . . 32
6.3.3.7 ucp_am_handler_param_t . . . 32
6.3.3.8 ucp_listener_accept_handler_t . . . 32
6.3.3.9 ucp_am_recv_param_t . . . 32
6.3.3.10 ucp_address_t . . . 32
6.3.3.11 ucp_listener_h . . . 33
6.3.3.12 ucp_worker_h . . . 33
6.3.3.13 ucp_listener_accept_callback_t . . . 33
6.3.3.14 ucp_listener_conn_callback_t . . . 33
6.3.3.15 ucp_listener_conn_handler_t . . . 34
6.3.3.16 ucp_wakeup_event_t . . . 34
6.3.4 Enumeration Type Documentation . . . 34
6.3.4.1 ucp_worker_params_field . . . 34
6.3.4.2 ucp_worker_flags_t . . . 35
6.3.4.3 ucp_listener_params_field . . . 35
6.3.4.4 ucp_worker_address_flags_t . . . 35
6.3.4.5 ucp_worker_attr_field . . . 35
6.3.4.6 ucp_worker_address_attr_field . . . 36
6.3.4.7 ucp_listener_attr_field . . . 36
6.3.4.8 ucp_conn_request_attr_field . . . 36
6.3.4.9 ucp_am_cb_flags . . . 37
6.3.4.10 ucp_send_am_flags . . . 37
6.3.4.11 ucp_wakeup_event_types . . . 37
6.3.5 Function Documentation . . . 38
6.3.5.1 ucp_worker_create() . . . 38
6.3.5.2 ucp_worker_destroy() . . . 38
6.3.5.3 ucp_worker_query() . . . 39
6.3.5.4 ucp_worker_print_info() . . . 39
6.3.5.5 ucp_worker_release_address() . . . 40
6.3.5.6 ucp_worker_address_query() . . . 40
6.3.5.7 ucp_worker_progress() . . . 40
6.3.5.8 ucp_stream_worker_poll() . . . 41
6.3.5.9 ucp_listener_create() . . . 41
6.3.5.10 ucp_listener_destroy() . . . 42
6.3.5.11 ucp_listener_query() . . . 42
6.3.5.12 ucp_conn_request_query() . . . 43
6.3.5.13 ucp_listener_reject() . . . 43

6.3.5.14 ucp_worker_set_am_recv_handler() 44
6.3.5.15 ucp_worker_fence() 44
6.3.5.16 ucp_worker_flush_nbx() 45
6.3.5.17 ucp_worker_flush() 45
6.3.5.18 ucp_worker_get_address() 46
6.3.5.19 ucp_worker_set_am_handler() 46
6.3.5.20 ucp_worker_flush_nb() 47
6.4 UCP Memory routines 48
6.4.1 Detailed Description 50
6.4.2 Data Structure Documentation 50
6.4.2.1 struct ucp_rkey_compare_params 50
6.4.2.2 struct ucp_mem_map_params 50
6.4.2.3 struct ucp_mem_advise_params 51
6.4.2.4 struct ucp_memh_pack_params 51
6.4.2.5 struct ucp_memh_buffer_release_params 51
6.4.2.6 struct ucp_mem_attr 52
6.4.3 Typedef Documentation 52
6.4.3.1 ucp_rkey_compare_params_t 52
6.4.3.2 ucp_mem_map_params_t 52
6.4.3.3 ucp_mem_advice_t 52
6.4.3.4 ucp_mem_advise_params_t 52
6.4.3.5 ucp_memh_pack_params_t 52
6.4.3.6 ucp_memh_buffer_release_params_t 52
6.4.3.7 ucp_rkey_h 53
6.4.3.8 ucp_mem_h 53
6.4.3.9 ucp_mem_attr_t 53
6.4.4 Enumeration Type Documentation 53
6.4.4.1 ucp_mem_map_params_field 53
6.4.4.2 ucp_mem_advise_params_field 53
6.4.4.3 anonymous enum 54
6.4.4.4 anonymous enum 54
6.4.4.5 ucp_mem_advice 55
6.4.4.6 ucp_memh_pack_params_field 55
6.4.4.7 ucp_memh_pack_flags 55
6.4.4.8 ucp_mem_attr_field 55
6.4.5 Function Documentation 56
6.4.5.1 ucp_rkey_compare() 56
6.4.5.2 ucp_mem_map() 56
6.4.5.3 ucp_mem_unmap() 58
6.4.5.4 ucp_mem_query() 58

6.4.5.5 ucp_mem_print_info() 58
6.4.5.6 ucp_mem_advise() 59
6.4.5.7 ucp_memh_pack() 59
6.4.5.8 ucp_memh_buffer_release() 60
6.4.5.9 ucp_ep_rkey_unpack() 60
6.4.5.10 ucp_rkey_ptr() 61
6.4.5.11 ucp_rkey_destroy() 61
6.4.5.12 ucp_rkey_pack() 62
6.4.5.13 ucp_rkey_buffer_release() 62
6.5 UCP Wake-up routines 64
6.5.1 Detailed Description 64
6.5.2 Function Documentation 64
6.5.2.1 ucp_worker_get_efd() 64
6.5.2.2 ucp_worker_wait() 65
6.5.2.3 ucp_worker_wait_mem() 65
6.5.2.4 ucp_worker_arm() 66
6.5.2.5 ucp_worker_signal() 67
6.6 UCP Endpoint 68
6.6.1 Detailed Description 70
6.6.2 Data Structure Documentation 70
6.6.2.1 struct ucp_ep_evaluate_perf_param_t 70
6.6.2.2 struct ucp_ep_evaluate_perf_attr_t 70
6.6.2.3 struct ucp_stream_poll_ep 70
6.6.2.4 struct ucp_ep_attr 70
6.6.2.5 struct ucp_ep_params 71
6.6.2.6 struct ucp_transport_entry_t 72
6.6.2.7 struct ucp_transports_t 73
6.6.3 Typedef Documentation 73
6.6.3.1 ucp_ep_perf_param_field_t 73
6.6.3.2 ucp_ep_perf_attr_field_t 73
6.6.3.3 ucp_stream_poll_ep_t 73
6.6.3.4 ucp_ep_attr_t 74
6.6.3.5 ucp_ep_h 74
6.6.3.6 ucp_conn_request_h 74
6.6.3.7 ucp_am_callback_t 74
6.6.3.8 ucp_am_recv_callback_t 74
6.6.3.9 ucp_ep_params_t 75
6.6.4 Enumeration Type Documentation 75
6.6.4.1 ucp_ep_params_field 75
6.6.4.2 ucp_ep_params_flags_field 76

6.6.4.3 ucp_ep_close_flags_t 76
6.6.4.4 ucp_ep_perf_param_field 77
6.6.4.5 ucp_ep_perf_attr_field 77
6.6.4.6 ucp_cb_param_flags 77
6.6.4.7 ucp_ep_attr_field 78
6.6.4.8 ucp_ep_close_mode 78
6.6.4.9 ucp_err_handling_mode_t 78
6.6.5 Function Documentation 79
6.6.5.1 ucp_ep_create() 79
6.6.5.2 ucp_ep_close_nbx() 80
6.6.5.3 ucp_ep_print_info() 80
6.6.5.4 ucp_ep_flush_nbx() 80
6.6.5.5 ucp_ep_evaluate_perf() 81
6.6.5.6 ucp_ep_query() 81
6.6.5.7 ucp_request_release() 83
6.6.5.8 ucp_ep_destroy() 83
6.6.5.9 ucp_disconnect_nb() 83
6.6.5.10 ucp_request_test() 83
6.6.5.11 ucp_ep_flush() 84
6.6.5.12 ucp_ep_modify_nb() 84
6.6.5.13 ucp_ep_close_nb() 84
6.6.5.14 ucp_ep_flush_nb() 85
6.7 UCP Communication routines 86
6.7.1 Detailed Description 90
6.7.2 Data Structure Documentation 90
6.7.2.1 struct ucp_request_attr_t 90
6.7.2.2 struct ucp_err_handler 90
6.7.3 Typedef Documentation 90
6.7.3.1 ucp_tag_t 90
6.7.3.2 ucp_tag_message_h 91
6.7.3.3 ucp_datatype_t 91
6.7.3.4 ucp_send_callback_t 91
6.7.3.5 ucp_send_nbx_callback_t 91
6.7.3.6 ucp_err_handler_cb_t 91
6.7.3.7 ucp_err_handler_t 92
6.7.3.8 ucp_stream_recv_callback_t 92
6.7.3.9 ucp_stream_recv_nbx_callback_t 92
6.7.3.10 ucp_tag_recv_callback_t 93
6.7.3.11 ucp_tag_recv_nbx_callback_t 93
6.7.3.12 ucp_am_recv_data_nbx_callback_t 93

6.7.4 Enumeration Type Documentation 94
6.7.4.1 ucp_atomic_op_t 94
6.7.4.2 ucp_stream_recv_flags_t 94
6.7.4.3 ucp_op_attr_t 94
6.7.4.4 ucp_req_attr_field 95
6.7.4.5 ucp_am_recv_attr_t 95
6.7.4.6 ucp_am_handler_param_field 96
6.7.4.7 ucp_atomic_post_op_t 96
6.7.4.8 ucp_atomic_fetch_op_t 96
6.7.5 Function Documentation 97
6.7.5.1 ucp_request_query() 97
6.7.5.2 ucp_am_send_nbx() 97
6.7.5.3 ucp_am_recv_data_nbx() 98
6.7.5.4 ucp_am_data_release() 99
6.7.5.5 ucp_stream_send_nbx() 99
6.7.5.6 ucp_tag_send_nbx() 100
6.7.5.7 ucp_tag_send_sync_nbx() 101
6.7.5.8 ucp_stream_recv_nbx() 101
6.7.5.9 ucp_stream_recv_data_nb() 102
6.7.5.10 ucp_tag_recv_nbx() 103
6.7.5.11 ucp_tag_probe_nb() 103
6.7.5.12 ucp_tag_msg_recv_nbx() 104
6.7.5.13 ucp_put_nbx() 105
6.7.5.14 ucp_get_nbx() 106
6.7.5.15 ucp_atomic_op_nbx() 107
6.7.5.16 ucp_request_check_status() 108
6.7.5.17 ucp_tag_recv_request_test() 108
6.7.5.18 ucp_stream_recv_request_test() 109
6.7.5.19 ucp_request_cancel() 109
6.7.5.20 ucp_stream_data_release() 109
6.7.5.21 ucp_request_free() 110
6.7.5.22 ucp_request_alloc() 110
6.7.5.23 ucp_request_is_completed() 110
6.7.5.24 ucp_put() 111
6.7.5.25 ucp_get() 111
6.7.5.26 ucp_atomic_add32() 112
6.7.5.27 ucp_atomic_add64() 113
6.7.5.28 ucp_atomic_fadd32() 113
6.7.5.29 ucp_atomic_fadd64() 114
6.7.5.30 ucp_atomic_swap32() 115

6.7.5.31 ucp_atomic_swap64() 116
6.7.5.32 ucp_atomic_cswap32() 116
6.7.5.33 ucp_atomic_cswap64() 117
6.7.5.34 ucp_am_send_nb() 118
6.7.5.35 ucp_stream_send_nb() 119
6.7.5.36 ucp_stream_recv_nb() 119
6.7.5.37 ucp_tag_send_nb() 120
6.7.5.38 ucp_tag_send_nbr() 121
6.7.5.39 ucp_tag_send_sync_nb() 123
6.7.5.40 ucp_tag_recv_nb() 123
6.7.5.41 ucp_tag_recv_nbr() 124
6.7.5.42 ucp_tag_msg_recv_nb() 125
6.7.5.43 ucp_put_nbi() 126
6.7.5.44 ucp_put_nb() 126
6.7.5.45 ucp_get_nbi() 127
6.7.5.46 ucp_get_nb() 128
6.7.5.47 ucp_atomic_post() 128
6.7.5.48 ucp_atomic_fetch_nb() 129
6.8 UCP Configuration 131
6.8.1 Detailed Description 131
6.8.2 Data Structure Documentation 131
6.8.2.1 struct ucp_params 131
6.8.3 Typedef Documentation 133
6.8.3.1 ucp_params_t 133
6.8.3.2 ucp_config_t 133
6.8.4 Function Documentation 134
6.8.4.1 ucp_config_read() 134
6.8.4.2 ucp_config_release() 134
6.8.4.3 ucp_config_modify() 135
6.8.4.4 ucp_config_print() 135
6.9 UCP Data type routines 136
6.9.1 Detailed Description 137
6.9.2 Data Structure Documentation 137
6.9.2.1 struct ucp_dt_iov 137
6.9.2.2 struct ucp_datatype_attr 137
6.9.3 Macro Definition Documentation 138
6.9.3.1 ucp_dt_make_contig 138
6.9.3.2 ucp_dt_make_iov 138
6.9.4 Typedef Documentation 138
6.9.4.1 ucp_dt_iov_t 139

6.9.4.2 ucp_generic_dt_ops_t 139
6.9.4.3 ucp_datatype_attr_t 139
6.9.5 Enumeration Type Documentation 139
6.9.5.1 ucp_dt_type 139
6.9.5.2 ucp_datatype_attr_field 140
6.9.6 Function Documentation 140
6.9.6.1 ucp_dt_create_generic() 140
6.9.6.2 ucp_dt_destroy() 140
6.9.6.3 ucp_dt_query() 141
6.9.7 Variable Documentation 141
6.9.7.1 start_pack 141
6.9.7.2 start_unpack 141
6.9.7.3 packed_size 142
6.9.7.4 pack 142
6.9.7.5 unpack 142
6.9.7.6 finish 143
6.10 Unified Communication Transport (UCT) API 144
6.10.1 Detailed Description 144
6.11 UCT Communication Resource 145
6.11.1 Detailed Description 149
6.11.2 Data Structure Documentation 150
6.11.2.1 struct uct_md_resource_desc 150
6.11.2.2 struct uct_component_attr 150
6.11.2.3 struct uct_tl_resource_desc 151
6.11.2.4 struct uct_iface_attr 151
6.11.2.5 struct uct_iface_attr.cap 151
6.11.2.6 struct uct_iface_attr.cap.put 152
6.11.2.7 struct uct_iface_attr.cap.get 152
6.11.2.8 struct uct_iface_attr.cap.am 152
6.11.2.9 struct uct_iface_attr.cap.tag 153
6.11.2.10 struct uct_iface_attr.cap.tag.recv 153
6.11.2.11 struct uct_iface_attr.cap.tag.eager 153
6.11.2.12 struct uct_iface_attr.cap.tag.rndv 153
6.11.2.13 struct uct_iface_attr.cap.atomic32 153
6.11.2.14 struct uct_iface_attr.cap.atomic64 153
6.11.2.15 struct uct_iface_params 154
6.11.2.16 union uct_iface_params.mode 154
6.11.2.17 struct uct_iface_params.mode.device 155
6.11.2.18 struct uct_iface_params.mode.sockaddr 155
6.11.2.19 struct uct_ep_params 155

6.11.2.20 struct uct_completion 158
6.11.2.21 struct uct_pending_req 158
6.11.2.22 struct uct_iov 159
6.11.3 Typedef Documentation 159
6.11.3.1 uct_md_resource_desc_t 159
6.11.3.2 uct_component_attr_t 159
6.11.3.3 uct_tl_resource_desc_t 159
6.11.3.4 uct_component_h 160
6.11.3.5 uct_iface_h 160
6.11.3.6 uct_iface_config_t 160
6.11.3.7 uct_md_config_t 160
6.11.3.8 uct_cm_config_t 160
6.11.3.9 uct_ep_h 160
6.11.3.10 uct_mem_h 160
6.11.3.11 uct_rkey_t 160
6.11.3.12 uct_md_h 161
6.11.3.13 uct_md_ops_t 161
6.11.3.14 uct_rkey_ctx_h 161
6.11.3.15 uct_iface_attr_t 161
6.11.3.16 uct_iface_params_t 161
6.11.3.17 uct_ep_attr_t 161
6.11.3.18 uct_md_attr_t 161
6.11.3.19 uct_completion_t 161
6.11.3.20 uct_pending_req_t 161
6.11.3.21 uct_worker_h 162
6.11.3.22 uct_md_t 162
6.11.3.23 uct_am_trace_type_t 162
6.11.3.24 uct_device_addr_t 162
6.11.3.25 uct_iface_addr_t 162
6.11.3.26 uct_ep_addr_t 162
6.11.3.27 uct_ep_params_t 162
6.11.3.28 uct_ep_connect_params_t 162
6.11.3.29 uct_cm_attr_t 162
6.11.3.30 uct_cm_t 163
6.11.3.31 uct_cm_h 163
6.11.3.32 uct_listener_attr_t 163
6.11.3.33 uct_listener_h 163
6.11.3.34 uct_listener_params_t 163
6.11.3.35 uct_tag_context_t 163
6.11.3.36 uct_tag_t 163

6.11.3.37 uct_worker_cb_id_t 163
6.11.3.38 uct_conn_request_h 163
6.11.3.39 uct_iov_t 164
6.11.3.40 uct_completion_callback_t 164
6.11.3.41 uct_pending_callback_t 164
6.11.3.42 uct_error_handler_t 164
6.11.3.43 uct_pending_purge_callback_t 165
6.11.3.44 uct_pack_callback_t 165
6.11.3.45 uct_unpack_callback_t 165
6.11.3.46 uct_async_event_cb_t 166
6.11.4 Enumeration Type Documentation 166
6.11.4.1 uct_component_attr_field 166
6.11.4.2 anonymous enum 166
6.11.4.3 uct_device_type_t 167
6.11.4.4 uct_iface_event_types 167
6.11.4.5 uct_flush_flags 167
6.11.4.6 uct_progress_types 168
6.11.4.7 uct_cb_flags 168
6.11.4.8 uct_iface_open_mode 168
6.11.4.9 uct_iface_params_field 169
6.11.4.10 uct_ep_params_field 169
6.11.4.11 uct_iface_feature 170
6.11.4.12 anonymous enum 170
6.11.4.13 uct_cb_param_flags 171
6.11.5 Function Documentation 171
6.11.5.1 uct_query_components() 171
6.11.5.2 uct_release_component_list() 172
6.11.5.3 uct_component_query() 172
6.11.5.4 uct_md_open() 172
6.11.5.5 uct_md_close() 173
6.11.5.6 uct_md_query_tl_resources() 173
6.11.5.7 uct_release_tl_resource_list() 174
6.11.5.8 uct_md_iface_config_read() 174
6.11.5.9 uct_config_release() 175
6.11.5.10 uct_iface_open() 175
6.11.5.11 uct_iface_close() 175
6.11.5.12 uct_iface_query() 176
6.11.5.13 uct_iface_get_device_address() 176
6.11.5.14 uct_iface_get_address() 176
6.11.5.15 uct_iface_is_reachable() 177

6.11.5.16 uct_ep_check() 177
6.11.5.17 uct_iface_event_fd_get() 178
6.11.5.18 uct_iface_event_arm() 178
6.11.5.19 uct_iface_mem_alloc() 178
6.11.5.20 uct_iface_mem_free() 179
6.11.5.21 uct_ep_create() 179
6.11.5.22 uct_ep_destroy() 180
6.11.5.23 uct_ep_get_address() 180
6.11.5.24 uct_ep_connect_to_ep() 180
6.11.5.25 uct_iface_flush() 181
6.11.5.26 uct_iface_fence() 181
6.11.5.27 uct_ep_pending_add() 182
6.11.5.28 uct_ep_pending_purge() 182
6.11.5.29 uct_ep_flush() 182
6.11.5.30 uct_ep_fence() 183
6.11.5.31 uct_iface_progress_enable() 183
6.11.5.32 uct_iface_progress_disable() 184
6.11.5.33 uct_iface_progress() 184
6.11.5.34 uct_completion_update_status() 184
6.12 UCT Communication Context 185
6.12.1 Detailed Description 185
6.12.2 Enumeration Type Documentation 185
6.12.2.1 uct_alloc_method_t 185
6.12.3 Function Documentation 186
6.12.3.1 uct_worker_create() 186
6.12.3.2 uct_worker_destroy() 186
6.12.3.3 uct_worker_progress_register_safe() 186
6.12.3.4 uct_worker_progress_unregister_safe() 187
6.12.3.5 uct_config_get() 187
6.12.3.6 uct_config_modify() 189
6.12.3.7 uct_worker_progress() 189
6.13 UCT Memory Domain 190
6.13.1 Detailed Description 192
6.13.2 Data Structure Documentation 192
6.13.2.1 struct uct_md_attr 192
6.13.2.2 struct uct_md_attr.cap 192
6.13.2.3 struct uct_md_mem_attr 192
6.13.2.4 struct uct_allocated_memory 193
6.13.2.5 struct uct_rkey_bundle 193
6.13.2.6 struct uct_mem_alloc_params_t 194

6.13.2.7 struct uct_mem_alloc_params_t.mds 194
6.13.3 Typedef Documentation 194
6.13.3.1 uct_md_mem_attr_field_t 194
6.13.3.2 uct_md_mem_attr_t 194
6.13.3.3 uct_allocated_memory_t 195
6.13.3.4 uct_rkey_bundle_t 195
6.13.4 Enumeration Type Documentation 195
6.13.4.1 uct_sockaddr_accessibility_t 195
6.13.4.2 anonymous enum 195
6.13.4.3 uct_md_mem_flags 196
6.13.4.4 uct_mem_advice_t 197
6.13.4.5 uct_md_mem_attr_field 197
6.13.4.6 uct_mem_alloc_params_field_t 197
6.13.5 Function Documentation 198
6.13.5.1 uct_md_mem_query() 198
6.13.5.2 uct_md_query() 198
6.13.5.3 uct_md_mem_advise() 199
6.13.5.4 uct_md_mem_reg() 199
6.13.5.5 uct_md_mem_dereg() 200
6.13.5.6 uct_md_detect_memory_type() 200
6.13.5.7 uct_mem_alloc() 200
6.13.5.8 uct_mem_free() 201
6.13.5.9 uct_md_config_read() 201
6.13.5.10 uct_md_is_sockaddr_accessible() 202
6.13.5.11 uct_md_mkey_pack() 202
6.13.5.12 uct_rkey_unpack() 202
6.13.5.13 uct_rkey_ptr() 203
6.13.5.14 uct_rkey_release() 203
6.14 UCT Active messages 204
6.14.1 Detailed Description 204
6.14.2 Typedef Documentation 204
6.14.2.1 uct_am_callback_t 205
6.14.2.2 uct_am_tracer_t 205
6.14.3 Enumeration Type Documentation 205
6.14.3.1 uct_msg_flags 205
6.14.3.2 uct_am_trace_type 206
6.14.4 Function Documentation 206
6.14.4.1 uct_iface_set_am_handler() 206
6.14.4.2 uct_iface_set_am_tracer() 207
6.14.4.3 uct_iface_release_desc() 207

6.14.4.4 uct_ep_am_short() . . . 207
6.14.4.5 uct_ep_am_short_iov() . . . 208
6.14.4.6 uct_ep_am_bcopy() . . . 208
6.14.4.7 uct_ep_am_zcopy() . . . 208
6.15 UCT Remote memory access operations . . . 210
6.15.1 Detailed Description . . . 210
6.15.2 Function Documentation . . . 210
6.15.2.1 uct_ep_put_short() . . . 210
6.15.2.2 uct_ep_put_bcopy() . . . 210
6.15.2.3 uct_ep_put_zcopy() . . . 210
6.15.2.4 uct_ep_get_short() . . . 211
6.15.2.5 uct_ep_get_bcopy() . . . 211
6.15.2.6 uct_ep_get_zcopy() . . . 211
6.16 UCT Atomic operations . . . 213
6.16.1 Detailed Description . . . 213
6.16.2 Function Documentation . . . 213
6.16.2.1 uct_ep_atomic_cswap64() . . . 213
6.16.2.2 uct_ep_atomic_cswap32() . . . 213
6.16.2.3 uct_ep_atomic32_post() . . . 213
6.16.2.4 uct_ep_atomic64_post() . . . 214
6.16.2.5 uct_ep_atomic32_fetch() . . . 214
6.16.2.6 uct_ep_atomic64_fetch() . . . 214
6.17 UCT Tag matching operations . . . 215
6.17.1 Detailed Description . . . 215
6.17.2 Typedef Documentation . . . 215
6.17.2.1 uct_tag_unexp_eager_cb_t . . . 216
6.17.2.2 uct_tag_unexp_rndv_cb_t . . . 216
6.17.3 Function Documentation . . . 217
6.17.3.1 uct_ep_tag_eager_short() . . . 217
6.17.3.2 uct_ep_tag_eager_bcopy() . . . 218
6.17.3.3 uct_ep_tag_eager_zcopy() . . . 218
6.17.3.4 uct_ep_tag_rndv_zcopy() . . . 219
6.17.3.5 uct_ep_tag_rndv_cancel() . . . 220
6.17.3.6 uct_ep_tag_rndv_request() . . . 220
6.17.3.7 uct_iface_tag_recv_zcopy() . . . 221
6.17.3.8 uct_iface_tag_recv_cancel() . . . 221
6.18 UCT client-server operations . . . 223
6.18.1 Detailed Description . . . 225
6.18.2 Data Structure Documentation . . . 226
6.18.2.1 struct uct_ep_connect_params . . . 226

6.18.2.2 struct uct_cm_attr . . . 226
6.18.2.3 struct uct_listener_attr . . . 226
6.18.2.4 struct uct_listener_params . . . 226
6.18.2.5 struct uct_cm_ep_priv_data_pack_args . . . 227
6.18.2.6 struct uct_cm_ep_resolve_args . . . 227
6.18.2.7 struct uct_cm_remote_data . . . 228
6.18.2.8 struct uct_cm_listener_conn_request_args . . . 228
6.18.2.9 struct uct_cm_ep_client_connect_args . . . 228
6.18.2.10 struct uct_cm_ep_server_conn_notify_args . . . 229
6.18.3 Typedef Documentation . . . 229
6.18.3.1 uct_cm_ep_priv_data_pack_args_t . . . 229
6.18.3.2 uct_cm_ep_resolve_args_t . . . 229
6.18.3.3 uct_cm_remote_data_t . . . 229
6.18.3.4 uct_cm_listener_conn_request_args_t . . . 229
6.18.3.5 uct_cm_ep_client_connect_args_t . . . 230
6.18.3.6 uct_cm_ep_server_conn_notify_args_t . . . 230
6.18.3.7 uct_sockaddr_conn_request_callback_t . . . 230
6.18.3.8 uct_cm_listener_conn_request_callback_t . . . 230
6.18.3.9 uct_cm_ep_server_conn_notify_callback_t . . . 231
6.18.3.10 uct_cm_ep_client_connect_callback_t . . . 231
6.18.3.11 uct_ep_disconnect_cb_t . . . 231
6.18.3.12 uct_cm_ep_priv_data_pack_callback_t . . . 232
6.18.3.13 uct_cm_ep_resolve_callback_t . . . 232
6.18.4 Enumeration Type Documentation . . . 232
6.18.4.1 uct_cm_attr_field . . . 232
6.18.4.2 uct_listener_attr_field . . . 233
6.18.4.3 uct_listener_params_field . . . 233
6.18.4.4 uct_ep_connect_params_field . . . 233
6.18.4.5 uct_cm_ep_priv_data_pack_args_field . . . 233
6.18.4.6 uct_cm_ep_resolve_args_field . . . 234
6.18.4.7 uct_cm_remote_data_field . . . 234
6.18.4.8 uct_cm_listener_conn_request_args_field . . . 234
6.18.4.9 uct_cm_ep_client_connect_args_field . . . 235
6.18.4.10 uct_cm_ep_server_conn_notify_args_field . . . 235
6.18.5 Function Documentation . . . 236
6.18.5.1 uct_iface_accept() . . . 236
6.18.5.2 uct_iface_reject() . . . 236
6.18.5.3 uct_ep_connect() . . . 236
6.18.5.4 uct_ep_disconnect() . . . 237
6.18.5.5 uct_cm_open() . . . 237

6.18.5.6 uct_cm_close() 238
6.18.5.7 uct_cm_query() 238
6.18.5.8 uct_cm_config_read() 238
6.18.5.9 uct_cm_client_ep_conn_notify() 239
6.18.5.10 uct_listener_create() 239
6.18.5.11 uct_listener_destroy() 240
6.18.5.12 uct_listener_reject() 240
6.18.5.13 uct_listener_query() 240
6.19 UCT interface operations and capabilities 241
6.19.1 Detailed Description 241
6.19.2 Macro Definition Documentation 241
6.19.2.1 UCT_IFACE_FLAG_AM_SHORT 242
6.19.2.2 UCT_IFACE_FLAG_AM_BCOPY 242
6.19.2.3 UCT_IFACE_FLAG_AM_ZCOPY 242
6.19.2.4 UCT_IFACE_FLAG_PENDING 242
6.19.2.5 UCT_IFACE_FLAG_PUT_SHORT 242
6.19.2.6 UCT_IFACE_FLAG_PUT_BCOPY 242
6.19.2.7 UCT_IFACE_FLAG_PUT_ZCOPY 242
6.19.2.8 UCT_IFACE_FLAG_GET_SHORT 243
6.19.2.9 UCT_IFACE_FLAG_GET_BCOPY 243
6.19.2.10 UCT_IFACE_FLAG_GET_ZCOPY 243
6.19.2.11 UCT_IFACE_FLAG_ATOMIC_CPU 243
6.19.2.12 UCT_IFACE_FLAG_ATOMIC_DEVICE 243
6.19.2.13 UCT_IFACE_FLAG_ERRHANDLE_SHORT_BUF 243
6.19.2.14 UCT_IFACE_FLAG_ERRHANDLE_BCOPY_BUF 243
6.19.2.15 UCT_IFACE_FLAG_ERRHANDLE_ZCOPY_BUF 243
6.19.2.16 UCT_IFACE_FLAG_ERRHANDLE_AM_ID 243
6.19.2.17 UCT_IFACE_FLAG_ERRHANDLE_REMOTE_MEM 244
6.19.2.18 UCT_IFACE_FLAG_ERRHANDLE_BCOPY_LEN 244
6.19.2.19 UCT_IFACE_FLAG_ERRHANDLE_PEER_FAILURE 244
6.19.2.20 UCT_IFACE_FLAG_EP_CHECK 244
6.19.2.21 UCT_IFACE_FLAG_CONNECT_TO_IFACE 244
6.19.2.22 UCT_IFACE_FLAG_CONNECT_TO_EP 244
6.19.2.23 UCT_IFACE_FLAG_CONNECT_TO_SOCKADDR 244
6.19.2.24 UCT_IFACE_FLAG_AM_DUP 245
6.19.2.25 UCT_IFACE_FLAG_CB_SYNC 245
6.19.2.26 UCT_IFACE_FLAG_CB_ASYNC 245
6.19.2.27 UCT_IFACE_FLAG_EP_KEEPALIVE 245
6.19.2.28 UCT_IFACE_FLAG_TAG_EAGER_SHORT 245
6.19.2.29 UCT_IFACE_FLAG_TAG_EAGER_BCOPY 245

6.19.2.30 UCT_IFACE_FLAG_TAG_EAGER_ZCOPY 245
6.19.2.31 UCT_IFACE_FLAG_TAG_RNDV_ZCOPY 245
6.19.2.32 UCT_IFACE_FLAG_INTER_NODE 245
6.20 UCT interface for asynchronous event capabilities 247
6.20.1 Detailed Description 247
6.20.2 Macro Definition Documentation 247
6.20.2.1 UCT_IFACE_FLAG_EVENT_SEND_COMP 247
6.20.2.2 UCT_IFACE_FLAG_EVENT_RECV 247
6.20.2.3 UCT_IFACE_FLAG_EVENT_RECV_SIG 247
6.20.2.4 UCT_IFACE_FLAG_EVENT_FD 247
6.20.2.5 UCT_IFACE_FLAG_EVENT_ASYNC_CB 247
6.21 Unified Communication Services (UCS) API 248
6.21.1 Detailed Description 248
6.22 UCS Communication Resource 249
6.22.1 Detailed Description 250
6.22.2 Data Structure Documentation 250
6.22.2.1 struct ucs_sock_addr 250
6.22.3 Typedef Documentation 250
6.22.3.1 ucs_async_event_cb_t 250
6.22.3.2 ucs_sock_addr_t 250
6.22.3.3 ucs_memory_type_t 251
6.22.3.4 ucs_time_t 251
6.22.3.5 ucs_status_ptr_t 251
6.22.4 Enumeration Type Documentation 251
6.22.4.1 ucs_callbackq_flags 251
6.22.4.2 ucs_memory_type 251
6.22.4.3 ucs_status_t 252
6.22.4.4 ucs_thread_mode_t 253
6.22.5 Function Documentation 253
6.22.5.1 ucs_async_set_event_handler() 253
6.22.5.2 ucs_async_add_timer() 254
6.22.5.3 ucs_async_remove_handler() 254
6.22.5.4 ucs_async_modify_handler() 255
6.22.5.5 ucs_async_context_create() 255
6.22.5.6 ucs_async_context_destroy() 255
6.22.5.7 ucs_async_poll() 256

7 Data Structure Documentation 257

7.1 ucp_generic_dt_ops Struct Reference 257
7.1.1 Detailed Description 257

7.2 uct_tag_context Struct Reference 257
7.2.1 Detailed Description 258
7.2.2 Field Documentation 258
7.2.2.1 tag_consumed_cb 258
7.2.2.2 completed_cb 258
7.2.2.3 rndv_cb 259
7.2.2.4 priv 259

8 Example Documentation 261
8.1 ucp_client_server.c 261
8.2 ucp_hello_world.c 273
8.3 uct_hello_world.c 282

Index 293

Chapter 1

Preface

1.1 Scope of the Document

This document describes the UCX programming interface. The programming interface exposes a high performance communication API, which provides basic building blocks for PGAS, Message Passing Interface (MPI), Big-Data, Analytics, File I/O, and storage library developers.

1.2 Audience

This manual is intended for programmers who want to develop parallel programming models like OpenSHMEM, MPI, UPC, Chapel, etc. The manual assumes that the reader is familiar with the following:

- Basic concepts of two-sided, one-sided, atomic, and collective operations
- C programming language

1.3 Document Status

This section briefly describes a list of open issues in the UCX specification.

- UCP API - work in progress
- UCT API - work in progress

1.4 License

UCX project follows open source development model and the software is licensed under BSD-3 license.

Chapter 2

Introduction

2.1 Motivation

A communication middleware abstracts the vendor-specific software and hardware interfaces. They bridge the semantic and functionality gap between the programming models and the software and hardware network interfaces by providing data transfer interfaces and implementation, optimized protocols for data transfer between various memories, and managing network resources. There are many communication middleware APIs and libraries to support parallel programming models such as MPI, OpenSHMEM, and task-based models.

Current communication middleware designs typically take two approaches. First, communication middleware such as Intel's PSM (previously Qlogic), Mellanox's MXM, and IBM's PAMI provide high-performance implementations for specific network hardware. Second, communication middleware such as VMI, Cactus, ARMCI, GASNet, and Open MPI are tightly coupled to a specific programming model. Communication middleware designed with either of this design approach requires significant porting effort to move a new network interface or programming model.

To achieve functional and performance portability across architectures and programming models, we introduce Unified Communication X (UCX).

2.2 UCX

Unified Communication X (UCX) is a set of network APIs and their implementations for high throughput computing. UCX is a combined effort of national laboratories, industry, and academia to design and implement a high-performing and highly-scalable network stack for next generation applications and systems. UCX design provides the ability to tailor its APIs and network functionality to suit a wide variety of application domains. We envision that these APIs will satisfy the networking needs of many programming models such as the Message Passing Interface (MPI), OpenSHMEM, Partitioned Global Address Space (PGAS) languages, task-based paradigms, and I/O bound applications.

The initial focus is on supporting semantics such as point-to-point communications (one-sided and two-sided), collective communication, and remote atomic operations required for popular parallel programming models. Also, the initial UCX reference implementation is targeted to support current network technologies such as:

- Open Fabrics - InfiniBand (Mellanox, Qlogic, IBM), iWARP, RoCE
- Cray uGNI - GEMINI and ARIES interconnects
- Shared memory (MMAP, Posix, CMA, KNEM, XPMEM, etc.)
- Ethernet (TCP/UDP)

UCX design goals are focused on performance and scalability, while efficiently supporting popular and emerging programming models.

UCX's API and design do not impose architectural constraints on the network hardware nor require any specific capabilities to the support the programming model functionality. This is achieved by keeping the API flexible and ability to support the missing functionality efficiently in the software.

Extreme scalability is an important design goal for UCX. To achieve this, UCX follows these design principles:

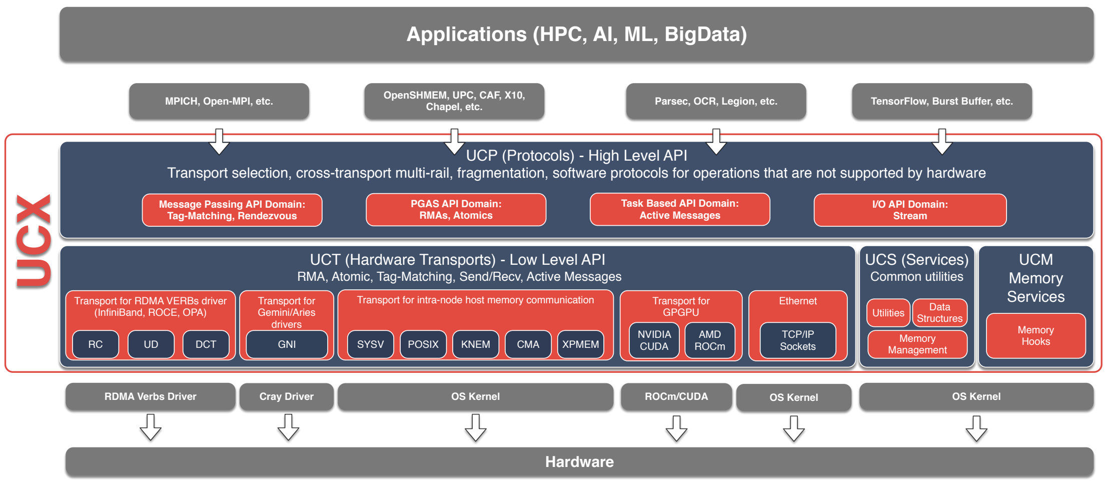
- Minimal memory consumption : Design avoids data-structures that scale with the number of processing elements (i.e., order N data structures), and share resources among multiple programming models.
- Low-latency Interfaces: Design provides at least two sets of APIs with one set focused on the performance, and the other focused on functionality.
- High bandwidth - With minimal software overhead combined and support for multi-rail and multi-device capabilities, the design provides all the hooks that are necessary for exploiting hardware bandwidth capabilities.
- Asynchronous Progress: API provides non-blocking communication interfaces and design supports asynchronous progress required for communication and computation overlap
- Resilience - the API exposes communication control hooks required for fault tolerant communication library implementation.

UCX design provides native support for hybrid programming models. The design enables resource sharing, optimal memory usage, and progress engine coordination to efficiently implement hybrid programming models. For example, hybrid applications that use both OpenSHMEM and MPI programming models will be able to select between a single-shared UCX network context or a stand alone UCX network context for each one of them. Such flexibility, optimized resource sharing, and reduced memory consumption, improve network and application performance.

Chapter 3

Design

The UCX framework consists of the three main components: UC-Services (UCS), UC-Transports (UCT), and UC-Protocols (UCP). Each one of these components exports a public API, and can be used as a stand-alone library.



Applications (HPC, AI, ML, BigData)
MPICH, Open-MPI, etc.
OpenSHMEM, UPC, CAF, X10, Chapel, etc.
Parsec, OCR, Legion, etc.
TensorFlow, Burst Buffer, etc.
UCX
UCP (Protocols) - High Level API
Transport selection, cross-transport multi-rail, fragmentation, software protocols for operations that are not supported by hardware
Message Passing API Domain: Tag-Matching, Rendezvous
PGAS API Domain: RMAs, Atomics
Task Based API Domain: Active Messages
I/O API Domain: Stream
UCT (Hardware Transports) - Low Level API
RMA, Atomic, Tag-Matching, Send/Recv, Active Messages
Transport for RDMA VERBs driver (InfiniBand, ROCE, OPA)
RC
UD
DCT
Transport for Gemini/Aries drivers
GNI
Transport for intra-node host memory communication
SYSV
POSIX
KNEM
CMA
XPMEM
Transport for GPGPU
NVIDIA CUDA
AMD ROCm
Ethernet
TCP/IP Sockets
UCS (Services)
Common utilities
Utilities
Data Structures
Memory Management
UCM Memory Services
Memory Hooks
RDMA Verbs Driver
Cray Driver
OS Kernel
ROCm/CUDA
OS Kernel
OS Kernel
Hardware

Figure 3.1: UCX Framework Architecture

3.1 UCS

UCS is a service layer that provides the necessary functionality for implementing portable and efficient utilities. This layer includes the following services:

- an abstraction for accessing platform specific functionality (atomic operations, thread safety, etc.),
- tools for efficient memory management (memory pools, memory allocators, and memory allocators hooks),
- commonly used data structures (hashes, trees, lists).

3.2 UCT

UCT is a transport layer that abstracts the differences across various hardware architectures and provides a low-level API that enables the implementation of communication protocols. The primary goal of the layer is to provide direct and efficient access to hardware network functionality. For this purpose, UCT relies on vendor provided low-level drivers such as uGNI, Verbs, shared memory, ROCM, CUDA. In addition, the layer provides constructs for communication context management (thread-based and application level), and allocation and management of device-specific memories including those found in accelerators. In terms of communication APIs, UCT defines interfaces for immediate (short), buffered copy-and-send (bcopy), and zero-copy (zcopy) communication operations.

Short: This type of operation is optimized for small messages that can be posted and completed in place.

Bcopy: This type of operation is optimized for medium size messages that are typically sent through a so-called bouncing-buffer. This auxiliary buffer is typically allocated given network constraints and ready for immediate utilization by the hardware. Since a custom data packing routine could be provided, this method can be used for non-contiguous i/o.

Zcopy: This type of operation exposes zero-copy memory-to-memory communication semantics, which means that message is sent directly from user buffer, or received directly to user buffer, without being copied between the network layers.

3.3 UCP

UCP implements higher-level protocols that are typically used by message passing (MPI) and PGAS programming models by using lower-level capabilities exposed through the UCT layer. UCP is provides the following functionality: ability to select different transports for communication, message fragmentation, multi-rail communication, and initializing and finalizing the library. Currently, the API has the following classes of interfaces: Initialization, Remote Memory Access (RMA) communication, Atomic Memory Operations (AMO), Active Message, Tag-Matching, and Collectives.

Initialization: This subset of interfaces defines the communication context setup, queries the network capabilities, and initializes the local communication endpoints. The context represented by the UCX context is an abstraction of the network transport resources. The communication endpoint setup interfaces initialize the UCP endpoint, which is an abstraction of all the necessary resources associated with a particular connection. The communication endpoints are used as input to all communication operations to describe the source and destination of the communication.

RMA: This subset of interfaces defines one-sided communication operations such as PUT and GET, required for implementing low overhead, direct memory access communications constructs needed by both distributed and shared memory programming models. UCP includes a separate set of interfaces for communicating non-contiguous data. This functionality was included to support various programming models' communication requirements and leverage the scatter/gather capabilities of modern network hardware.

AMO: This subset of interfaces provides support for atomically performing operations on the remote memory, an important class of operations for PGAS programming models, particularly OpenSHMEM.

Tag Matching: This interface supports tag-matching for send-receive semantics which is a key communication semantic defined by the MPI specification.

Stream : The API provides order and reliable communication semantics. Data is treated as an ordered sequence of bytes pushed through the connection. In contrast of tag-matching interface, the size of each individual send does not necessarily have to match the size of each individual receive, as long as the total number of bytes is the same. This API is designed to match widely used BSD-socket based programming models.

Active Message: A subset of functionality where the incoming packet invokes a sender-specified callback in order to be processed by the receiving process. As an example, the two-sided MPI interface can easily be implemented on top of such a concept (TBD: cite openmpi). However, these interfaces are more general and suited for other programming paradigms where the receiver process does not prepost receives, but expects to react to incoming packets directly. Like RMA and tag-matching interfaces, the active message interface provides separate APIs for different message types and non-contiguous data.

Collectives: This subset of interfaces defines group communication and synchronization operations. The collective operations include barrier, all-to-one, all-to-all, and reduction operations. When possible, we will take advantage of hardware acceleration for collectives (e.g., InfiniBand Switch collective acceleration).

Chapter 4

Conventions and Notations

This section describes the conventions and notations in the UCX specification.

4.1 Blocking Behavior

The blocking UCX routines return only when a UCX operation is complete. After the return, the resources used in the UCX routine are available for reuse.

4.2 Non-blocking Behavior

The non-blocking UCX routines return immediately, independent of operation completion. After the return, the resources used for the routines are not necessarily available for reuse.

4.3 Fairness

UCX routines do not guarantee fairness. However, the routines enable UCX consumers to write efficient and fair programs.

4.4 Interaction with Signal Handler Functions

If UCX routines are invoked from a signal handler function, the behavior of the program is undefined.

Chapter 5

Deprecated List

Global ucp_am_send_nb (ucp_ep_h ep, uint16_t id, const void ∗buffer, size_t count, ucp_datatype_↩ t datatype, ucp_send_callback_t cb, unsigned flags)

Use ucp_am_send_nbx instead.

Global ucp_atomic_add32 (ucp_ep_h ep, uint32_t add, uint64_t remote_addr, ucp_rkey_h rkey)

Replaced by ucp_atomic_post with opcode UCP_ATOMIC_POST_OP_ADD.

Global ucp_atomic_add64 (ucp_ep_h ep, uint64_t add, uint64_t remote_addr, ucp_rkey_h rkey)

Replaced by ucp_atomic_post with opcode UCP_ATOMIC_POST_OP_ADD.

Global ucp_atomic_cswap32 (ucp_ep_h ep, uint32_t compare, uint32_t swap, uint64_t remote_addr, ucp↩ _rkey_h rkey, uint32_t ∗result)

Replaced by ucp_atomic_fetch_nb with opcode UCP_ATOMIC_FETCH_OP_CSWAP.

Global ucp_atomic_cswap64 (ucp_ep_h ep, uint64_t compare, uint64_t swap, uint64_t remote_addr, ucp↩ _rkey_h rkey, uint64_t ∗result)

Replaced by ucp_atomic_fetch_nb with opcode UCP_ATOMIC_FETCH_OP_CSWAP.

Global ucp_atomic_fadd32 (ucp_ep_h ep, uint32_t add, uint64_t remote_addr, ucp_rkey_h rkey, uint32_t ∗result)

Replaced by ucp_atomic_fetch_nb with opcode UCP_ATOMIC_FETCH_OP_FADD.

Global ucp_atomic_fadd64 (ucp_ep_h ep, uint64_t add, uint64_t remote_addr, ucp_rkey_h rkey, uint64_t ∗result)

Replaced by ucp_atomic_fetch_nb with opcode UCP_ATOMIC_FETCH_OP_FADD.

Global ucp_atomic_fetch_nb (ucp_ep_h ep, ucp_atomic_fetch_op_t opcode, uint64_t value, void ∗result, size_t op_size, uint64_t remote_addr, ucp_rkey_h rkey, ucp_send_callback_t cb)

Use ucp_atomic_op_nbx with the flag UCP_OP_ATTR_FIELD_REPLY_BUFFER instead.

Global ucp_atomic_fetch_op_t

Use ucp_atomic_op_nbx and ucp_atomic_op_t instead.

Global ucp_atomic_post (ucp_ep_h ep, ucp_atomic_post_op_t opcode, uint64_t value, size_t op_size, uint64_t remote_addr, ucp_rkey_h rkey)

Use ucp_atomic_op_nbx without the flag UCP_OP_ATTR_FIELD_REPLY_BUFFER instead.

Global ucp_atomic_post_op_t

Use ucp_atomic_op_nbx and ucp_atomic_op_t instead.

Global ucp_atomic_swap32 (ucp_ep_h ep, uint32_t swap, uint64_t remote_addr, ucp_rkey_h rkey, uint32_t ∗result)

Replaced by ucp_atomic_fetch_nb with opcode UCP_ATOMIC_FETCH_OP_SWAP.

Global ucp_atomic_swap64 (ucp_ep_h ep, uint64_t swap, uint64_t remote_addr, ucp_rkey_h rkey, uint64_t ∗result)

Replaced by ucp_atomic_fetch_nb with opcode UCP_ATOMIC_FETCH_OP_SWAP.

Global ucp_disconnect_nb (ucp_ep_h ep)

Replaced by ucp_ep_close_nb.

Global ucp_ep_close_mode

Use ucp_ep_close_nbx and ucp_ep_close_flags_t instead.

Global ucp_ep_close_nb (ucp_ep_h ep, unsigned mode)

Use ucp_ep_close_nbx instead.

Global ucp_ep_destroy (ucp_ep_h ep)

Replaced by ucp_ep_close_nb.

Global ucp_ep_flush (ucp_ep_h ep)

Replaced by ucp_ep_flush_nb.

Global ucp_ep_flush_nb (ucp_ep_h ep, unsigned flags, ucp_send_callback_t cb)

Use ucp_ep_flush_nbx instead.

Global ucp_ep_modify_nb (ucp_ep_h ep, const ucp_ep_params_t ∗params)

Use ucp_listener_conn_handler_t instead of ucp_listener_accept_handler_t, if you have other use case please submit an issue on `https://github.com/openucx/ucx` or report to `ucx-group@elist.ornl.↩ gov`

Global ucp_get (ucp_ep_h ep, void ∗buffer, size_t length, uint64_t remote_addr, ucp_rkey_h rkey)

Replaced by ucp_get_nb.

Global ucp_get_nb (ucp_ep_h ep, void ∗buffer, size_t length, uint64_t remote_addr, ucp_rkey_h rkey, ucp↩ _send_callback_t cb)

Use ucp_get_nbx instead.

Global ucp_get_nbi (ucp_ep_h ep, void ∗buffer, size_t length, uint64_t remote_addr, ucp_rkey_h rkey)

Use ucp_get_nbx without passing the flag UCP_OP_ATTR_FIELD_CALLBACK instead. If a request pointer is returned, release it immediately by ucp_request_free.

Global ucp_listener_accept_handler_t

Replaced by ucp_listener_conn_handler_t.

Global ucp_listener_accept_handler_t

Replaced by ucp_listener_conn_handler_t.

Global ucp_put (ucp_ep_h ep, const void ∗buffer, size_t length, uint64_t remote_addr, ucp_rkey_h rkey)

Replaced by ucp_put_nb. The following example implements the same functionality using ucp_put_nb :

Global ucp_put_nb (ucp_ep_h ep, const void ∗buffer, size_t length, uint64_t remote_addr, ucp_rkey_h rkey, ucp_send_callback_t cb)

Use ucp_put_nbx instead.

Global ucp_put_nbi (ucp_ep_h ep, const void ∗buffer, size_t length, uint64_t remote_addr, ucp_rkey_h rkey)

Use ucp_put_nbx without passing the flag UCP_OP_ATTR_FIELD_CALLBACK instead. If a request pointer is returned, release it immediately by ucp_request_free.

Global ucp_request_is_completed (void ∗request)

Replaced by ucp_request_test.

Global ucp_request_release (void ∗request)

Replaced by ucp_request_free.

Global ucp_request_test (void ∗request, ucp_tag_recv_info_t ∗info)

Replaced by ucp_tag_recv_request_test and ucp_request_check_status depends on use case.

Global ucp_rkey_buffer_release (void ∗rkey_buffer)

Replaced by ucp_memh_buffer_release().

Global ucp_rkey_pack (ucp_context_h context, ucp_mem_h memh, void ∗∗rkey_buffer_p, size_t ∗size_p)

Replaced by ucp_memh_pack().

Global ucp_stream_recv_nb (ucp_ep_h ep, void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_↩ stream_recv_callback_t cb, size_t ∗length, unsigned flags)

Use ucp_stream_recv_nbx instead.

Global ucp_stream_send_nb (ucp_ep_h ep, const void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_send_callback_t cb, unsigned flags)

Use ucp_stream_send_nbx instead.

Global ucp_tag_msg_recv_nb (ucp_worker_h worker, void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_tag_message_h message, ucp_tag_recv_callback_t cb)

Use ucp_tag_recv_nbx instead.

Global ucp_tag_recv_nb (ucp_worker_h worker, void ∗buffer, size_t count, ucp_datatype_t datatype, ucp↩ _tag_t tag, ucp_tag_t tag_mask, ucp_tag_recv_callback_t cb)

Use ucp_tag_recv_nbx instead.

Global ucp_tag_recv_nbr (ucp_worker_h worker, void ∗buffer, size_t count, ucp_datatype_t datatype, ucp↩ _tag_t tag, ucp_tag_t tag_mask, void ∗req)

Use ucp_tag_recv_nbx with the flag UCP_OP_ATTR_FIELD_REQUEST instead.

Global ucp_tag_send_nb (ucp_ep_h ep, const void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_↩ tag_t tag, ucp_send_callback_t cb)

Use ucp_tag_send_nbx instead.

Global ucp_tag_send_nbr (ucp_ep_h ep, const void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_↩ tag_t tag, void ∗req)

Use ucp_tag_send_nbx with the flag UCP_OP_ATTR_FIELD_REQUEST instead.

Global ucp_tag_send_sync_nb (ucp_ep_h ep, const void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_tag_t tag, ucp_send_callback_t cb)

Use ucp_tag_send_sync_nbx instead.

Global ucp_worker_flush (ucp_worker_h worker)

Replaced by ucp_worker_flush_nb. The following example implements the same functionality using ucp_worker_flush_nb :

Global ucp_worker_flush_nb (ucp_worker_h worker, unsigned flags, ucp_send_callback_t cb)

Use ucp_worker_flush_nbx instead.

Global ucp_worker_get_address (ucp_worker_h worker, ucp_address_t ∗∗address_p, size_t ∗address_↩ length_p)

Use ucp_worker_query with the flag UCP_WORKER_ATTR_FIELD_ADDRESS in order to obtain the worker address.

Global ucp_worker_set_am_handler (ucp_worker_h worker, uint16_t id, ucp_am_callback_t cb, void ∗arg, uint32_t flags)

Use ucp_worker_set_am_recv_handler instead.

Chapter 6

Module Documentation

6.1 Unified Communication Protocol (UCP) API

Modules

- UCP Application Context
- UCP Worker
- UCP Memory routines
- UCP Wake-up routines
- UCP Endpoint
- UCP Communication routines
- UCP Configuration
- UCP Data type routines

6.1.1 Detailed Description

This section describes UCP API.

6.2 UCP Application Context

Data Structures

- struct ucp_lib_attr

  Lib attributes. More...
- struct ucp_context_attr

  Context attributes. More...
- struct ucp_tag_recv_info

  UCP receive information descriptor. More...
- struct ucp_request_param_t

  Operation parameters passed to ucp_tag_send_nbx, ucp_tag_send_sync_nbx, ucp_tag_recv_nbx, ucp_put_nbx, ucp_get_nbx, ucp_am_send_nbx and ucp_am_recv_data_nbx. More...
- union ucp_request_param_t.cb
- union ucp_request_param_t.recv_info

Macros

- #define UCP_ENTITY_NAME_MAX 32

  Maximum size of the UCP entity name in structure of entity attributes provided by a query method.

Typedefs

- typedef struct ucp_lib_attr ucp_lib_attr_t

  Lib attributes.
- typedef struct ucp_context_attr ucp_context_attr_t

  Context attributes.
- typedef struct ucp_tag_recv_info ucp_tag_recv_info_t

  UCP receive information descriptor.
- typedef struct ucp_context ∗ ucp_context_h

  UCP Application Context.
- typedef void(∗ ucp_request_init_callback_t) (void ∗request)

  Request initialization callback.
- typedef void(∗ ucp_request_cleanup_callback_t) (void ∗request)

  Request cleanup callback.

Enumerations

- enum ucp_params_field {
  UCP_PARAM_FIELD_FEATURES = UCS_BIT(0), UCP_PARAM_FIELD_REQUEST_SIZE = UCS_BIT(1),
  UCP_PARAM_FIELD_REQUEST_INIT = UCS_BIT(2), UCP_PARAM_FIELD_REQUEST_CLEANUP = U↩
  CS_BIT(3),
  UCP_PARAM_FIELD_TAG_SENDER_MASK = UCS_BIT(4), UCP_PARAM_FIELD_MT_WORKERS_SHARED
  = UCS_BIT(5), UCP_PARAM_FIELD_ESTIMATED_NUM_EPS = UCS_BIT(6), UCP_PARAM_FIELD_ESTIMATED_NUM_PP
  = UCS_BIT(7),
  UCP_PARAM_FIELD_NAME = UCS_BIT(8) }

  UCP context parameters field mask.
- enum ucp_feature {
  UCP_FEATURE_TAG = UCS_BIT(0), UCP_FEATURE_RMA = UCS_BIT(1), UCP_FEATURE_AMO32 =
  UCS_BIT(2), UCP_FEATURE_AMO64 = UCS_BIT(3),
  UCP_FEATURE_WAKEUP = UCS_BIT(4), UCP_FEATURE_STREAM = UCS_BIT(5), UCP_FEATURE_AM
  = UCS_BIT(6), UCP_FEATURE_EXPORTED_MEMH = UCS_BIT(7) }

UCP configuration features.

- enum ucp_lib_attr_field { UCP_LIB_ATTR_FIELD_MAX_THREAD_LEVEL = UCS_BIT(0) }

  UCP library attributes field mask.
- enum ucp_context_attr_field { UCP_ATTR_FIELD_REQUEST_SIZE = UCS_BIT(0), UCP_ATTR_FIELD_THREAD_MODE = UCS_BIT(1), UCP_ATTR_FIELD_MEMORY_TYPES = UCS_BIT(2), UCP_ATTR_FIELD_NAME = UC↩ S_BIT(3) }

  UCP context attributes field mask.

Functions

- ucs_status_t ucp_lib_query (ucp_lib_attr_t ∗attr)

  Get attributes of the UCP library.
- void ucp_get_version (unsigned ∗major_version, unsigned ∗minor_version, unsigned ∗release_number)

  Get UCP library version.
- const char ∗ ucp_get_version_string (void)

  Get UCP library version as a string.
- static ucs_status_t ucp_init (const ucp_params_t ∗params, const ucp_config_t ∗config, ucp_context_h ∗context_p)

  UCP context initialization.
- void ucp_cleanup (ucp_context_h context_p)

  Release UCP application context.
- ucs_status_t ucp_context_query (ucp_context_h context_p, ucp_context_attr_t ∗attr)

  Get attributes specific to a particular context.
- void ucp_context_print_info (const ucp_context_h context, FILE ∗stream)

  Print context information.

6.2.1 Detailed Description

Application context is a primary concept of UCP design which provides an isolation mechanism, allowing resources associated with the context to separate or share network communication context across multiple instances of applications.

This section provides a detailed description of this concept and routines associated with it.

6.2.2 Data Structure Documentation

6.2.2.1 struct ucp_lib_attr

The structure defines the attributes that characterize the Library.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_lib_attr_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
ucs_thread_mode_t	max_thread_level	Maximum level of thread support of the library, which is permanent throughout the lifetime of the library. Accordingly, the user can call ucp_worker_create with appropriate ucp_worker_params_t::thread_mode. For supported thread levels please see ucs_thread_mode_t.

6.2.2.2 struct ucp_context_attr

The structure defines the attributes that characterize the particular context.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_context_attr_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
size_t	request_size	Size of UCP non-blocking request. When pre-allocated request is used (e.g. in ucp_tag_recv_nbr) it should have enough space to fit UCP request data, which is defined by this value.
ucs_thread_mode_t	thread_mode	Thread safe level of the context. For supported thread levels please see ucs_thread_mode_t.
uint64_t	memory_types	Mask of which memory types are supported, for supported memory types please see ucs_memory_type_t.
char	name[UCP_ENTITY_NAME_MAX]	Tracing and analysis tools can use name to identify this UCX context.

6.2.2.3 struct ucp_tag_recv_info

The UCP receive information descriptor is allocated by application and filled in with the information about the received message by ucp_tag_probe_nb or ucp_tag_recv_request_test routines or ucp_tag_recv_callback_t callback argument.

Examples:

ucp_client_server.c, and ucp_hello_world.c.

Data Fields

ucp_tag_t	sender_tag	Sender tag
size_t	length	The size of the received data

6.2.2.4 struct ucp_request_param_t

The structure ucp_request_param_t is used to specify datatype of operation, provide user request in case the external request is used, set completion callback and custom user data passed to this callback.

Example: implementation of function to send contiguous buffer to ep and invoke callback function at operation completion. If the operation completed immediately (status == UCS_OK) then callback is not called.

```
ucs_status_ptr_t send_data(ucp_ep_h ep, void *buffer, size_t length,
                           ucp_tag_t tag, void *request)
{
    ucp_request_param_t param = {
        .op_attr_mask               = UCP_OP_ATTR_FIELD_CALLBACK |
                                      UCP_OP_ATTR_FIELD_REQUEST,
        .request                    = request,
        .cb.send                    = custom_send_callback_f,
        .user_data                  = pointer_to_user_context_passed_to_cb
    };
    ucs_status_ptr_t status;

    status = ucp_tag_send_nbx(ep, buffer, length, tag, &param);
    if (UCS_PTR_IS_ERR(status)) {
        handle_error(status);
    } else if (status == UCS_OK) {
        // operation is completed
    }

    return status;
}
```

Examples:

ucp_client_server.c, and ucp_hello_world.c.

Data Fields

uint32_t	op_attr_mask	Mask of valid fields in this structure and operation flags, using bits from ucp_op_attr_t. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
uint32_t	flags	
void ∗	request	Request handle allocated by the user. There should be at least UCP request size bytes of available space before the *request*. The size of the UCP request can be obtained by ucp_context_query function.
union ucp_request_param_t	cb	Callback function that is invoked whenever the send or receive operation is completed.
ucp_datatype_t	datatype	Datatype descriptor for the elements in the buffer. In case the op_attr_mask & UCP_OP_ATTR_FIELD_DATATYPE bit is not set, then use default datatype ucp_dt_make_contig(1)
void ∗	user_data	Pointer to user data passed to callback function.
void ∗	reply_buffer	Reply buffer. Can be used for storing operation result, for example by ucp_atomic_op_nbx.
ucs_memory_type_t	memory_type	Memory type of the buffer. see ucs_memory_type_t for possible memory types. An optimization hint to avoid memory type detection for request buffer. If this value is not set (along with its corresponding bit in the op_attr_mask - UCP_OP_ATTR_FIELD_MEMORY_TYPE), then use default UCS_MEMORY_TYPE_UNKNOWN which means the memory type will be detected internally.
union ucp_request_param_t	recv_info	Pointer to the information where received data details are stored in case of an immediate completion of receive operation. The user has to provide a pointer to valid memory/variable which will be updated on function return.
ucp_mem_h	memh	Memory handle for pre-registered buffer. If the handle is provided, protocols that require registered memory can skip the registration step. As a result, the communication request overhead can be reduced and the request can be completed faster. The memory handle should be obtained by calling ucp_mem_map.

6.2.2.5 union ucp_request_param_t.cb

Callback function that is invoked whenever the send or receive operation is completed.

Data Fields

ucp_send_nbx_callback_t	send	
ucp_tag_recv_nbx_callback_t	recv	
ucp_stream_recv_nbx_callback_t	recv_stream	
ucp_am_recv_data_nbx_callback_t	recv_am	

6.2.2.6 union ucp_request_param_t.recv_info

Pointer to the information where received data details are stored in case of an immediate completion of receive operation. The user has to provide a pointer to valid memory/variable which will be updated on function return.

Data Fields

size_t ∗	length	
ucp_tag_recv_info_t ∗	tag_info	

6.2.3 Macro Definition Documentation

6.2.3.1 UCP_ENTITY_NAME_MAX

```
#define UCP_ENTITY_NAME_MAX 32
```

6.2.4 Typedef Documentation

6.2.4.1 ucp_lib_attr_t

```
typedef struct ucp_lib_attr ucp_lib_attr_t
```

The structure defines the attributes that characterize the Library.

6.2.4.2 ucp_context_attr_t

```
typedef struct ucp_context_attr ucp_context_attr_t
```

The structure defines the attributes that characterize the particular context.

6.2.4.3 ucp_tag_recv_info_t

```
typedef struct ucp_tag_recv_info ucp_tag_recv_info_t
```

The UCP receive information descriptor is allocated by application and filled in with the information about the received message by ucp_tag_probe_nb or ucp_tag_recv_request_test routines or ucp_tag_recv_callback_t callback argument.

6.2.4.4 ucp_context_h

```
typedef struct ucp_context* ucp_context_h
```

UCP application context (or just a context) is an opaque handle that holds a UCP communication instance's global information. It represents a single UCP communication instance. The communication instance could be an OS process (an application) that uses UCP library. This global information includes communication resources, endpoints, memory, temporary file storage, and other communication information directly associated with a specific UCP instance. The context also acts as an isolation mechanism, allowing resources associated with the context to manage multiple concurrent communication instances. For example, users using both MPI and OpenSHMEM sessions simultaneously can isolate their communication by allocating and using separate contexts for each of them. Alternatively, users can share the communication resources (memory, network resource context, etc.) between them by using the same application context. A message sent or a RMA operation performed in one application context cannot be received in any other application context.

6.2.4.5 ucp_request_init_callback_t

```
typedef void(* ucp_request_init_callback_t) (void *request)
```

This callback routine is responsible for the request initialization.

Parameters

`in`	*request*	Request handle to initialize.

6.2.4.6 ucp_request_cleanup_callback_t

```
typedef void(* ucp_request_cleanup_callback_t) (void *request)
```

This callback routine is responsible for cleanup of the memory associated with the request.

Parameters

`in`	*request*	Request handle to cleanup.

6.2.5 Enumeration Type Documentation

6.2.5.1 ucp_params_field

```
enum ucp_params_field
```

The enumeration allows specifying which fields in ucp_params_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_PARAM_FIELD_FEATURES	features
UCP_PARAM_FIELD_REQUEST_SIZE	request_size
UCP_PARAM_FIELD_REQUEST_INIT	request_init
UCP_PARAM_FIELD_REQUEST_CLEANUP	request_cleanup

Enumerator

UCP_PARAM_FIELD_TAG_SENDER_MASK	tag_sender_mask
UCP_PARAM_FIELD_MT_WORKERS_SHARED	mt_workers_shared
UCP_PARAM_FIELD_ESTIMATED_NUM_EPS	estimated_num_eps
UCP_PARAM_FIELD_ESTIMATED_NUM_PPN	estimated_num_ppn
UCP_PARAM_FIELD_NAME	name

6.2.5.2 ucp_feature

`enum ucp_feature`

The enumeration list describes the features supported by UCP. An application can request the features using UCP parameters during UCP initialization process.

Enumerator

UCP_FEATURE_TAG	Request tag matching support
UCP_FEATURE_RMA	Request remote memory access support
UCP_FEATURE_AMO32	Request 32-bit atomic operations support
UCP_FEATURE_AMO64	Request 64-bit atomic operations support
UCP_FEATURE_WAKEUP	Request interrupt notification support
UCP_FEATURE_STREAM	Request stream support
UCP_FEATURE_AM	Request Active Message support
UCP_FEATURE_EXPORTED_MEMH	Request support mapping a peer's memory handle that was created by ucp_mem_map and packed by ucp_memh_pack with the flag UCP_MEMH_PACK_FLAG_EXPORT and use it for local operations

6.2.5.3 ucp_lib_attr_field

`enum ucp_lib_attr_field`

The enumeration allows specifying which fields in ucp_lib_attr_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_LIB_ATTR_FIELD_MAX_THREAD_LEVEL	UCP library maximum supported thread level flag

6.2.5.4 ucp_context_attr_field

`enum ucp_context_attr_field`

The enumeration allows specifying which fields in ucp_context_attr_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_ATTR_FIELD_REQUEST_SIZE	UCP request size
UCP_ATTR_FIELD_THREAD_MODE	UCP context thread flag
UCP_ATTR_FIELD_MEMORY_TYPES	UCP supported memory types
UCP_ATTR_FIELD_NAME	UCP context name

6.2.6 Function Documentation

6.2.6.1 ucp_lib_query()

```
ucs_status_t ucp_lib_query (
             ucp_lib_attr_t * attr )
```

This routine fetches information about the UCP library attributes.

Parameters

out	*attr*	Filled with attributes of the UCP library.

Returns

Error code as defined by ucs_status_t

6.2.6.2 ucp_get_version()

```
void ucp_get_version (
             unsigned * major_version,
             unsigned * minor_version,
             unsigned * release_number )
```

This routine returns the UCP library version.

Parameters

out	*major_version*	Filled with library major version.
out	*minor_version*	Filled with library minor version.
out	*release_number*	Filled with library release number.

6.2.6.3 ucp_get_version_string()

```
const char* ucp_get_version_string (
             void )
```

This routine returns the UCP library version as a string which consists of: "major.minor.release".

6.2.6.4 ucp_init()

```
static ucs_status_t ucp_init (
            const ucp_params_t * params,
            const ucp_config_t * config,
            ucp_context_h * context_p )  [inline], [static]
```

This routine creates and initializes a UCP application context.

Warning

This routine must be called before any other UCP function call in the application.

This routine checks API version compatibility, then discovers the available network interfaces, and initializes the network resources required for discovering of the network and memory related devices. This routine is responsible for initialization all information required for a particular application scope, for example, MPI application, OpenSH↩ MEM application, etc.

Note

- Higher level protocols can add additional communication isolation, as MPI does with its communicator object. A single communication context may be used to support multiple MPI communicators.
- The context can be used to isolate the communication that corresponds to different protocols. For example, if MPI and OpenSHMEM are using UCP to isolate the MPI communication from the OpenSHMEM communication, users should use different application context for each of the communication libraries.

Parameters

in	*config*	UCP configuration descriptor allocated through ucp_config_read() routine.
in	*params*	User defined ucp_params_t configurations for the UCP application context.
out	*context↩ _p*	Initialized UCP application context.

Returns

Error code as defined by ucs_status_t

Examples:

ucp_client_server.c, and ucp_hello_world.c.

6.2.6.5 ucp_cleanup()

```
void ucp_cleanup (
            ucp_context_h context_p )
```

This routine finalizes and releases the resources associated with a UCP application context.

Warning

An application cannot call any UCP routine once the UCP application context released.

The cleanup process releases and shuts down all resources associated with the application context. After calling this routine, calling any UCP routine without calling UCP initialization routine is invalid.

Parameters

in	*context←_p*	Handle to UCP application context.

Examples:

ucp_client_server.c, and ucp_hello_world.c.

6.2.6.6 ucp_context_query()

```
ucs_status_t ucp_context_query (
             ucp_context_h context_p,
             ucp_context_attr_t * attr )
```

This routine fetches information about the context.

Parameters

in	*context←_p*	Handle to UCP application context.
out	*attr*	Filled with attributes of `context_p` context.

Returns

Error code as defined by ucs_status_t

6.2.6.7 ucp_context_print_info()

```
void ucp_context_print_info (
             const ucp_context_h context,
             FILE * stream )
```

This routine prints information about the context configuration: including memory domains, transport resources, and other useful information associated with the context.

Parameters

in	*context*	Print this context object's configuration.
in	*stream*	Output stream on which to print the information.

6.3 UCP Worker

Data Structures

- struct ucp_worker_attr

  UCP worker attributes. More...
- struct ucp_worker_params

  Tuning parameters for the UCP worker. More...
- struct ucp_worker_address_attr

  UCP worker address attributes. More...
- struct ucp_listener_attr

  UCP listener attributes. More...
- struct ucp_conn_request_attr

  UCP listener's connection request attributes. More...
- struct ucp_listener_params

  Parameters for a UCP listener object. More...
- struct ucp_am_handler_param

  Active Message handler parameters passed to ucp_worker_set_am_recv_handler routine. More...
- struct ucp_am_recv_param

  Operation parameters provided in ucp_am_recv_callback_t callback. More...
- struct ucp_listener_accept_handler
- struct ucp_listener_conn_handler

  UCP callback to handle the connection request in a client-server connection establishment flow. More...

Typedefs

- typedef struct ucp_worker_attr ucp_worker_attr_t

  UCP worker attributes.
- typedef struct ucp_worker_params ucp_worker_params_t

  Tuning parameters for the UCP worker.
- typedef struct ucp_worker_address_attr ucp_worker_address_attr_t

  UCP worker address attributes.
- typedef struct ucp_listener_attr ucp_listener_attr_t

  UCP listener attributes.
- typedef struct ucp_conn_request_attr ucp_conn_request_attr_t

  UCP listener's connection request attributes.
- typedef struct ucp_listener_params ucp_listener_params_t

  Parameters for a UCP listener object.
- typedef struct ucp_am_handler_param ucp_am_handler_param_t

  Active Message handler parameters passed to ucp_worker_set_am_recv_handler routine.
- typedef struct ucp_listener_accept_handler ucp_listener_accept_handler_t
- typedef struct ucp_am_recv_param ucp_am_recv_param_t

  Operation parameters provided in ucp_am_recv_callback_t callback.
- typedef struct ucp_address ucp_address_t

  UCP worker address.
- typedef struct ucp_listener ∗ ucp_listener_h

  UCP listen handle.
- typedef struct ucp_worker ∗ ucp_worker_h

  UCP Worker.
- typedef void(∗ ucp_listener_accept_callback_t) (ucp_ep_h ep, void ∗arg)

  A callback for accepting client/server connections on a listener ucp_listener_h.

- typedef void(∗ ucp_listener_conn_callback_t) (ucp_conn_request_h conn_request, void ∗arg)

  A callback for handling of incoming connection request conn_request from a client.
- typedef struct ucp_listener_conn_handler ucp_listener_conn_handler_t

  UCP callback to handle the connection request in a client-server connection establishment flow.
- typedef enum ucp_wakeup_event_types ucp_wakeup_event_t

  UCP worker wakeup events mask.

Enumerations

- enum ucp_worker_params_field {
  UCP_WORKER_PARAM_FIELD_THREAD_MODE = UCS_BIT(0), UCP_WORKER_PARAM_FIELD_CPU_MASK = UCS_BIT(1), UCP_WORKER_PARAM_FIELD_EVENTS = UCS_BIT(2), UCP_WORKER_PARAM_FIELD_USER_DATA = UCS_BIT(3),
  UCP_WORKER_PARAM_FIELD_EVENT_FD = UCS_BIT(4), UCP_WORKER_PARAM_FIELD_FLAGS = UCS_BIT(5), UCP_WORKER_PARAM_FIELD_NAME = UCS_BIT(6), UCP_WORKER_PARAM_FIELD_AM_ALIGNMENT = UCS_BIT(7),
  UCP_WORKER_PARAM_FIELD_CLIENT_ID = UCS_BIT(8) }

  UCP worker parameters field mask.
- enum ucp_worker_flags_t { UCP_WORKER_FLAG_IGNORE_REQUEST_LEAK = UCS_BIT(0) }

  UCP worker flags.
- enum ucp_listener_params_field { UCP_LISTENER_PARAM_FIELD_SOCK_ADDR = UCS_BIT(0), UCP_LISTENER_PARAM_FIELD_ACCEPT_HANDLER = UCS_BIT(1), UCP_LISTENER_PARAM_FIELD_CONN_HANDLER
  = UCS_BIT(2) }

  UCP listener parameters field mask.
- enum ucp_worker_address_flags_t { UCP_WORKER_ADDRESS_FLAG_NET_ONLY = UCS_BIT(0) }

  UCP worker address flags.
- enum ucp_worker_attr_field {
  UCP_WORKER_ATTR_FIELD_THREAD_MODE = UCS_BIT(0), UCP_WORKER_ATTR_FIELD_ADDRESS = UCS_BIT(1), UCP_WORKER_ATTR_FIELD_ADDRESS_FLAGS = UCS_BIT(2), UCP_WORKER_ATTR_FIELD_MAX_AM_
  = UCS_BIT(3),
  UCP_WORKER_ATTR_FIELD_NAME = UCS_BIT(4), UCP_WORKER_ATTR_FIELD_MAX_INFO_STRING = UCS_BIT(5) }

  UCP worker attributes field mask.
- enum ucp_worker_address_attr_field { UCP_WORKER_ADDRESS_ATTR_FIELD_UID = UCS_BIT(0) }

  UCP worker address attributes field mask.
- enum ucp_listener_attr_field { UCP_LISTENER_ATTR_FIELD_SOCKADDR = UCS_BIT(0) }

  UCP listener attributes field mask.
- enum ucp_conn_request_attr_field { UCP_CONN_REQUEST_ATTR_FIELD_CLIENT_ADDR = UCS_B←
  IT(0), UCP_CONN_REQUEST_ATTR_FIELD_CLIENT_ID = UCS_BIT(1) }

  UCP listener's connection request attributes field mask.
- enum ucp_am_cb_flags { UCP_AM_FLAG_WHOLE_MSG = UCS_BIT(0), UCP_AM_FLAG_PERSISTENT_DATA = UCS_BIT(1) }

  Flags for a UCP Active Message callback.
- enum ucp_send_am_flags {
  UCP_AM_SEND_FLAG_REPLY = UCS_BIT(0), UCP_AM_SEND_FLAG_EAGER = UCS_BIT(1), UCP_AM_SEND_FLAG_RNDV = UCS_BIT(2), UCP_AM_SEND_FLAG_COPY_HEADER = UCS_BIT(3),
  UCP_AM_SEND_REPLY = UCP_AM_SEND_FLAG_REPLY }

  Flags for sending a UCP Active Message.
- enum ucp_wakeup_event_types {
  UCP_WAKEUP_RMA = UCS_BIT(0), UCP_WAKEUP_AMO = UCS_BIT(1), UCP_WAKEUP_TAG_SEND = UCS_BIT(2), UCP_WAKEUP_TAG_RECV = UCS_BIT(3),
  UCP_WAKEUP_TX = UCS_BIT(10), UCP_WAKEUP_RX = UCS_BIT(11), UCP_WAKEUP_EDGE = UCS←
  _BIT(16) }

  UCP worker wakeup events mask.

Functions

- ucs_status_t ucp_worker_create (ucp_context_h context, const ucp_worker_params_t ∗params, ucp_worker_h ∗worker_p)

  Create a worker object.
- void ucp_worker_destroy (ucp_worker_h worker)

  Destroy a worker object.
- ucs_status_t ucp_worker_query (ucp_worker_h worker, ucp_worker_attr_t ∗attr)

  Get attributes specific to a particular worker.
- void ucp_worker_print_info (ucp_worker_h worker, FILE ∗stream)

  Print information about the worker.
- void ucp_worker_release_address (ucp_worker_h worker, ucp_address_t ∗address)

  Release an address of the worker object.
- ucs_status_t ucp_worker_address_query (ucp_address_t ∗address, ucp_worker_address_attr_t ∗attr)

  Get attributes of the particular worker address.
- unsigned ucp_worker_progress (ucp_worker_h worker)

  Progress all communications on a specific worker.
- ssize_t ucp_stream_worker_poll (ucp_worker_h worker, ucp_stream_poll_ep_t ∗poll_eps, size_t max_eps, unsigned flags)

  Poll for endpoints that are ready to consume streaming data.
- ucs_status_t ucp_listener_create (ucp_worker_h worker, const ucp_listener_params_t ∗params, ucp_listener_h ∗listener_p)

  Create a listener to accept connections on. Connection requests on the listener will arrive at a local address specified by the user.
- void ucp_listener_destroy (ucp_listener_h listener)

  Stop accepting connections on a local address of the worker object.
- ucs_status_t ucp_listener_query (ucp_listener_h listener, ucp_listener_attr_t ∗attr)

  Get attributes specific to a particular listener.
- ucs_status_t ucp_conn_request_query (ucp_conn_request_h conn_request, ucp_conn_request_attr_t ∗attr)

  Get attributes specific to a particular connection request received on the server side.
- ucs_status_t ucp_listener_reject (ucp_listener_h listener, ucp_conn_request_h conn_request)

  Reject an incoming connection request.
- ucs_status_t ucp_worker_set_am_recv_handler (ucp_worker_h worker, const ucp_am_handler_param_t ∗param)

  Add user defined callback for Active Message.
- ucs_status_t ucp_worker_fence (ucp_worker_h worker)

  Assures ordering between non-blocking operations.
- ucs_status_ptr_t ucp_worker_flush_nbx (ucp_worker_h worker, const ucp_request_param_t ∗param)

  Flush outstanding AMO and RMA operations on the worker.
- ucs_status_t ucp_worker_flush (ucp_worker_h worker)

  Flush outstanding AMO and RMA operations on the worker.
- ucs_status_t ucp_worker_get_address (ucp_worker_h worker, ucp_address_t ∗∗address_p, size_↩ t ∗address_length_p)

  Get the address of the worker object.
- ucs_status_t ucp_worker_set_am_handler (ucp_worker_h worker, uint16_t id, ucp_am_callback_t cb, void ∗arg, uint32_t flags)

  Add user defined callback for Active Message.
- ucs_status_ptr_t ucp_worker_flush_nb (ucp_worker_h worker, unsigned flags, ucp_send_callback_t cb)

  Flush outstanding AMO and RMA operations on the worker.

6.3.1 Detailed Description

UCP Worker routines

6.3.2 Data Structure Documentation

6.3.2.1 struct ucp_worker_attr

The structure defines the attributes which characterize the particular worker.

Examples:

ucp_hello_world.c.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_worker_attr_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
ucs_thread_mode_t	thread_mode	Thread safe level of the worker.
uint32_t	address_flags	Flags indicating requested details of the worker address. If UCP_WORKER_ATTR_FIELD_ADDRESS_FLAGS bit is set in the field_mask, this value should be set as well. Possible flags are specified in ucp_worker_address_flags_t. **Note** This is an input attribute.
ucp_address_t ∗	address	Worker address, which can be passed to remote instances of the UCP library in order to connect to this worker. The memory for the address handle is allocated by ucp_worker_query() routine, and must be released by using ucp_worker_release_address() routine.
size_t	address_length	Size of worker address in bytes.
size_t	max_am_header	Maximum allowed header size for ucp_am_send_nbx routine.
char	name[UCP_ENTITY_NAME_MAX]	Tracing and analysis tools can identify the worker using this name.
size_t	max_debug_string	Maximum debug string size that can be filled with ucp_request_query.

6.3.2.2 struct ucp_worker_params

The structure defines the parameters that are used for the UCP worker tuning during the UCP worker creation.

Examples:

ucp_client_server.c, and ucp_hello_world.c.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_worker_params_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.

Data Fields

ucs_thread_mode_t	thread_mode	The parameter thread_mode suggests the thread safety mode which worker and the associated resources should be created with. This is an optional parameter. The default value is UCS_THREAD_MODE_SINGLE and it is used when the value of the parameter is not set. When this parameter along with its corresponding bit in the field_mask - UCP_WORKER_PARAM_FIELD_THREAD_MODE is set, the ucp_worker_create attempts to create worker with this thread mode. The thread mode with which worker is created can differ from the suggested mode. The actual thread mode of the worker should be obtained using the query interface ucp_worker_query.
ucs_cpu_set_t	cpu_mask	Mask of which CPUs worker resources should preferably be allocated on. This value is optional. If it's not set (along with its corresponding bit in the field_mask - UCP_WORKER_PARAM_FIELD_CPU_MASK), resources are allocated according to system's default policy.
unsigned	events	Mask of events (ucp_wakeup_event_t) which are expected on wakeup. This value is optional. If it's not set (along with its corresponding bit in the field_mask - UCP_WORKER_PARAM_FIELD_EVENTS), all types of events will trigger on wakeup.
void *	user_data	User data associated with the current worker. This value is optional. If it's not set (along with its corresponding bit in the field_mask - UCP_WORKER_PARAM_FIELD_USER_DATA), it will default to NULL.
int	event_fd	External event file descriptor. This value is optional. If UCP_WORKER_PARAM_FIELD_EVENT_FD is set in the field_mask, events on the worker will be reported on the provided event file descriptor. In this case, calling ucp_worker_get_efd will result in an error. The provided file descriptor must be capable of aggregating notifications for arbitrary events, for example `epoll(7)` on Linux systems. user_data will be used as the event user-data on systems which support it. For example, on Linux, it will be placed in `epoll_data_t::ptr`, when returned from `epoll_wait(2)`. Otherwise, events will be reported to the event file descriptor returned from ucp_worker_get_efd().
uint64_t	flags	Worker flags. This value is optional. If UCP_WORKER_PARAM_FIELD_FLAGS is not set in the field_mask, the value of this field will default to 0.
const char *	name	Tracing and analysis tools can identify the worker using this name. To retrieve the worker's name, use ucp_worker_query, as the name you supply may be changed by UCX under some circumstances, e.g. a name conflict. This field is only assigned if you set UCP_WORKER_PARAM_FIELD_NAME in the field mask. If not, then a default unique name will be created for you.
size_t	am_alignment	Minimal address alignment of the active message data pointer as passed in argument *data* to the active message handler, defined as *ucp_am_recv_callback_t*.
uint64_t	client_id	Client id that is sent as part of the connection request payload when connecting to a remote socket address. On the remote side, this value can be obtained from ucp_conn_request_h using ucp_conn_request_query.

6.3.2.3 struct ucp_worker_address_attr

The structure defines the attributes of the particular worker address.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_worker_address_attr_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
uint64_t	worker_uid	Unique id of the worker this address belongs to.

6.3.2.4 struct ucp_listener_attr

The structure defines the attributes which characterize the particular listener.

Examples:

ucp_client_server.c.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_listener_attr_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
struct sockaddr_storage	sockaddr	Sockaddr on which this listener is listening for incoming connection requests.

6.3.2.5 struct ucp_conn_request_attr

The structure defines the attributes that characterize the particular connection request received on the server side.

Examples:

ucp_client_server.c.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_conn_request_attr_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
struct sockaddr_storage	client_address	The address of the remote client that sent the connection request to the server.
uint64_t	client_id	Remote client id if remote endpoint's flag UCP_EP_PARAMS_FLAGS_SEND_CLIENT_ID is set.

6.3.2.6 struct ucp_listener_params

This structure defines parameters for ucp_listener_create, which is used to listen for incoming client/server connections.

Examples:

ucp_client_server.c.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_listener_params_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
ucs_sock_addr_t	sockaddr	An address in the form of a sockaddr. This field is mandatory for filling (along with its corresponding bit in the field_mask - UCP_LISTENER_PARAM_FIELD_SOCK_ADDR). The ucp_listener_create routine will return with an error if sockaddr is not specified.
ucp_listener_accept_handler_t	accept_handler	Handler to endpoint creation in a client-server connection flow. In order for the callback inside this handler to be invoked, the UCP_LISTENER_PARAM_FIELD_ACCEPT_HANDLER needs to be set in the field_mask.
ucp_listener_conn_handler_t	conn_handler	Handler of an incoming connection request in a client-server connection flow. In order for the callback inside this handler to be invoked, the UCP_LISTENER_PARAM_FIELD_CONN_HANDLER needs to be set in the field_mask. **Note** User is expected to call ucp_ep_create with set UCP_EP_PARAM_FIELD_CONN_REQUEST flag to ucp_ep_params_t::field_mask and ucp_ep_params_t::conn_request in order to be able to receive communications.

6.3.2.7 struct ucp_am_handler_param

Examples:

ucp_client_server.c.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_am_handler_param_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
unsigned	id	Active Message id. **Warning** Value must be between 0 and UINT16_MAX.
uint32_t	flags	Handler flags as defined by ucp_am_cb_flags.
ucp_am_recv_callback_t	cb	Active Message callback. To clear the already set callback, this value should be set to NULL.
void ∗	arg	Active Message argument, which will be passed in to every invocation of ucp_am_recv_callback_t function as the *arg* argument.

6.3.2.8 struct ucp_am_recv_param

Examples:

ucp_client_server.c.

Data Fields

uint64_t	recv_attr	Mask of valid fields in this structure and receive operation flags, using bits from ucp_am_recv_attr_t. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
ucp_ep_h	reply_ep	Endpoint, which can be used for the reply to this message.

6.3.2.9 struct ucp_listener_accept_handler

Deprecated Replaced by ucp_listener_conn_handler_t.

Data Fields

ucp_listener_accept_callback_t	cb	Endpoint creation callback
void ∗	arg	User defined argument for the callback

6.3.2.10 struct ucp_listener_conn_handler

This structure is used for handling an incoming connection request on the listener. Setting this type of handler allows creating an endpoint on any other worker and not limited to the worker on which the listener was created.

Note

- Other than communication progress routines, it is allowed to call all other communication routines from the callback in the struct.
- The callback is thread safe with respect to the worker it is invoked on.
- It is the user's responsibility to avoid potential dead lock accessing different worker.

Data Fields

ucp_listener_conn_callback_t	cb	Connection request callback
void ∗	arg	User defined argument for the callback

6.3.3 Typedef Documentation

6.3.3.1 ucp_worker_attr_t

```
typedef struct ucp_worker_attr ucp_worker_attr_t
```

The structure defines the attributes which characterize the particular worker.

6.3.3.2 ucp_worker_params_t

```
typedef struct ucp_worker_params ucp_worker_params_t
```

The structure defines the parameters that are used for the UCP worker tuning during the UCP worker creation.

6.3.3.3 ucp_worker_address_attr_t

```
typedef struct ucp_worker_address_attr ucp_worker_address_attr_t
```

The structure defines the attributes of the particular worker address.

6.3.3.4 ucp_listener_attr_t

```
typedef struct ucp_listener_attr ucp_listener_attr_t
```

The structure defines the attributes which characterize the particular listener.

6.3.3.5 ucp_conn_request_attr_t

```
typedef struct ucp_conn_request_attr ucp_conn_request_attr_t
```

The structure defines the attributes that characterize the particular connection request received on the server side.

6.3.3.6 ucp_listener_params_t

```
typedef struct ucp_listener_params ucp_listener_params_t
```

This structure defines parameters for ucp_listener_create, which is used to listen for incoming client/server connections.

6.3.3.7 ucp_am_handler_param_t

```
typedef struct ucp_am_handler_param ucp_am_handler_param_t
```

6.3.3.8 ucp_listener_accept_handler_t

```
typedef struct ucp_listener_accept_handler ucp_listener_accept_handler_t
```

Deprecated Replaced by ucp_listener_conn_handler_t.

6.3.3.9 ucp_am_recv_param_t

```
typedef struct ucp_am_recv_param ucp_am_recv_param_t
```

6.3.3.10 ucp_address_t

```
typedef struct ucp_address ucp_address_t
```

The address handle is an opaque object that is used as an identifier for a worker instance.

6.3.3.11 ucp_listener_h

```
typedef struct ucp_listener* ucp_listener_h
```

The listener handle is an opaque object that is used for listening on a specific address and accepting connections from clients.

6.3.3.12 ucp_worker_h

```
typedef struct ucp_worker* ucp_worker_h
```

UCP worker is an opaque object representing the communication context. The worker represents an instance of a local communication resource and the progress engine associated with it. The progress engine is a construct that is responsible for asynchronous and independent progress of communication directives. The progress engine could be implemented in hardware or software. The worker object abstracts an instance of network resources such as a host channel adapter port, network interface, or multiple resources such as multiple network interfaces or communication ports. It could also represent virtual communication resources that are defined across multiple devices. Although the worker can represent multiple network resources, it is associated with a single UCX application context. All communication functions require a context to perform the operation on the dedicated hardware resource(s) and an endpoint to address the destination.

Note

Worker are parallel "threading points" that an upper layer may use to optimize concurrent communications.

6.3.3.13 ucp_listener_accept_callback_t

```
typedef void(* ucp_listener_accept_callback_t) (ucp_ep_h ep, void *arg)
```

This callback routine is invoked on the server side upon creating a connection to a remote client. The user can pass an argument to this callback. The user is responsible for releasing the *ep* handle using the ucp_ep_destroy() routine.

Parameters

in	*ep*	Handle to a newly created endpoint which is connected to the remote peer which has initiated the connection.
in	*arg*	User's argument for the callback.

6.3.3.14 ucp_listener_conn_callback_t

```
typedef void(* ucp_listener_conn_callback_t) (ucp_conn_request_h conn_request, void *arg)
```

This callback routine is invoked on the server side to handle incoming connections from remote clients. The user can pass an argument to this callback. The *conn_request* handle has to be released, either by ucp_ep_create or ucp_listener_reject routine.

Parameters

in	*conn_request*	Connection request handle.
in	*arg*	User's argument for the callback.

6.3.3.15 ucp_listener_conn_handler_t

```
typedef struct ucp_listener_conn_handler ucp_listener_conn_handler_t
```

This structure is used for handling an incoming connection request on the listener. Setting this type of handler allows creating an endpoint on any other worker and not limited to the worker on which the listener was created.

Note

- Other than communication progress routines, it is allowed to call all other communication routines from the callback in the struct.
- The callback is thread safe with respect to the worker it is invoked on.
- It is the user's responsibility to avoid potential dead lock accessing different worker.

6.3.3.16 ucp_wakeup_event_t

```
typedef enum ucp_wakeup_event_types ucp_wakeup_event_t
```

The enumeration allows specifying which events are expected on wakeup. Empty events are possible for any type of event except for UCP_WAKEUP_TX and UCP_WAKEUP_RX.

Note

Send completions are reported by POLLIN-like events (see poll man page). Since outgoing operations can be initiated at any time, UCP does not generate POLLOUT-like events, although it must be noted that outgoing operations may be queued depending upon resource availability.

6.3.4 Enumeration Type Documentation

6.3.4.1 ucp_worker_params_field

```
enum ucp_worker_params_field
```

The enumeration allows specifying which fields in ucp_worker_params_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_WORKER_PARAM_FIELD_THREAD_MODE	UCP thread mode
UCP_WORKER_PARAM_FIELD_CPU_MASK	Worker's CPU bitmap
UCP_WORKER_PARAM_FIELD_EVENTS	Worker's events bitmap
UCP_WORKER_PARAM_FIELD_USER_DATA	User data
UCP_WORKER_PARAM_FIELD_EVENT_FD	External event file descriptor
UCP_WORKER_PARAM_FIELD_FLAGS	Worker flags
UCP_WORKER_PARAM_FIELD_NAME	Worker name
UCP_WORKER_PARAM_FIELD_AM_ALIGNMENT	Alignment of active messages on the receiver
UCP_WORKER_PARAM_FIELD_CLIENT_ID	Client id

6.3.4.2 ucp_worker_flags_t

`enum ucp_worker_flags_t`

This enumeration allows specifying flags for ucp_worker_params_t::flags, which is used as parameter for ucp_worker_create.

Enumerator

UCP_WORKER_FLAG_IGNORE_REQUEST_LEAK	Do not print warnings about request leaks

6.3.4.3 ucp_listener_params_field

`enum ucp_listener_params_field`

The enumeration allows specifying which fields in ucp_listener_params_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_LISTENER_PARAM_FIELD_SOCK_ADDR	Sock address and length.
UCP_LISTENER_PARAM_FIELD_ACCEPT_HAN↩ DLER	User's callback and argument for handling the creation of an endpoint.User's callback and argument for handling the incoming connection request.
UCP_LISTENER_PARAM_FIELD_CONN_HANDL↩ ER	

6.3.4.4 ucp_worker_address_flags_t

`enum ucp_worker_address_flags_t`

The enumeration list describes possible UCP worker address flags, indicating what needs to be included to the worker address returned by ucp_worker_query() routine.

Enumerator

UCP_WORKER_ADDRESS_FLAG_NET_ONLY	Pack addresses of network devices only. Using such shortened addresses for the remote node peers will reduce the amount of wireup data being exchanged during connection establishment phase.

6.3.4.5 ucp_worker_attr_field

`enum ucp_worker_attr_field`

The enumeration allows specifying which fields in ucp_worker_attr_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_WORKER_ATTR_FIELD_THREAD_MODE	UCP thread mode
UCP_WORKER_ATTR_FIELD_ADDRESS	UCP address
UCP_WORKER_ATTR_FIELD_ADDRESS_FLAGS	UCP address flags
UCP_WORKER_ATTR_FIELD_MAX_AM_HEADER	Maximum header size used by UCP AM API
UCP_WORKER_ATTR_FIELD_NAME	UCP worker name
UCP_WORKER_ATTR_FIELD_MAX_INFO_STRING	Maximum size of info string

6.3.4.6 ucp_worker_address_attr_field

`enum ucp_worker_address_attr_field`

The enumeration allows specifying which fields in ucp_worker_address_attr_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_WORKER_ADDRESS_ATTR_FIELD_UID	Unique id of the worker

6.3.4.7 ucp_listener_attr_field

`enum ucp_listener_attr_field`

The enumeration allows specifying which fields in ucp_listener_attr_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_LISTENER_ATTR_FIELD_SOCKADDR	Sockaddr used for listening

6.3.4.8 ucp_conn_request_attr_field

`enum ucp_conn_request_attr_field`

The enumeration allows specifying which fields in ucp_conn_request_attr_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_CONN_REQUEST_ATTR_FIELD_CLIENT_ADDR	Client's address
UCP_CONN_REQUEST_ATTR_FIELD_CLIENT_ID	Remote client id

6.3.4.9 ucp_am_cb_flags

`enum ucp_am_cb_flags`

Flags that indicate how to handle UCP Active Messages.

Enumerator

UCP_AM_FLAG_WHOLE_MSG	Indicates that the entire message will be handled in one callback.
UCP_AM_FLAG_PERSISTENT_DATA	Guarantees that the specified ucp_am_recv_callback_t callback, will always be called with UCP_AM_RECV_ATTR_FLAG_DATA flag set, so the data will be accessible outside the callback, until ucp_am_data_release is called.

6.3.4.10 ucp_send_am_flags

`enum ucp_send_am_flags`

Flags dictate the behavior of ucp_am_send_nb and ucp_am_send_nbx routines.

Enumerator

UCP_AM_SEND_FLAG_REPLY	Force relevant reply endpoint to be passed to the data callback on the receiver.
UCP_AM_SEND_FLAG_EAGER	Force UCP to use only eager protocol for AM sends.
UCP_AM_SEND_FLAG_RNDV	Force UCP to use only rendezvous protocol for AM sends.
UCP_AM_SEND_FLAG_COPY_HEADER	The flag indicates that the header should be copied to an internal buffer in case it's needed after the send function returns. If this flag is specified, the header can be released immediately after the send function returns, even if the non-blocking send request is not completed.
UCP_AM_SEND_REPLY	Backward compatibility.

6.3.4.11 ucp_wakeup_event_types

`enum ucp_wakeup_event_types`

The enumeration allows specifying which events are expected on wakeup. Empty events are possible for any type of event except for UCP_WAKEUP_TX and UCP_WAKEUP_RX.

Note

Send completions are reported by POLLIN-like events (see poll man page). Since outgoing operations can be initiated at any time, UCP does not generate POLLOUT-like events, although it must be noted that outgoing operations may be queued depending upon resource availability.

Enumerator

UCP_WAKEUP_RMA	Remote memory access send completion
UCP_WAKEUP_AMO	Atomic operation send completion
UCP_WAKEUP_TAG_SEND	Tag send completion

Enumerator

UCP_WAKEUP_TAG_RECV	Tag receive completion
UCP_WAKEUP_TX	This event type will generate an event on completion of any outgoing operation (complete or partial, according to the underlying protocol) for any type of transfer (send, atomic, or RMA).
UCP_WAKEUP_RX	This event type will generate an event on completion of any receive operation (complete or partial, according to the underlying protocol).
UCP_WAKEUP_EDGE	Use edge-triggered wakeup. The event file descriptor will be signaled only for new events, rather than existing ones.

6.3.5 Function Documentation

6.3.5.1 ucp_worker_create()

```
ucs_status_t ucp_worker_create (
             ucp_context_h context,
             const ucp_worker_params_t * params,
             ucp_worker_h * worker_p )
```

This routine allocates and initializes a worker object. Each worker is associated with one and only one application context. In the same time, an application context can create multiple workers in order to enable concurrent access to communication resources. For example, application can allocate a dedicated worker for each application thread, where every worker can be progressed independently of others.

Note

The worker object is allocated within context of the calling thread

Parameters

in	*context*	Handle to UCP application context.
in	*params*	User defined ucp_worker_params_t configurations for the UCP worker.
out	*worker↩_p*	A pointer to the worker object allocated by the UCP library

Returns

Error code as defined by ucs_status_t

Examples:

ucp_client_server.c, and ucp_hello_world.c.

6.3.5.2 ucp_worker_destroy()

```
void ucp_worker_destroy (
             ucp_worker_h worker )
```

This routine releases the resources associated with a UCP worker.

Warning

Once the UCP worker destroy the worker handle cannot be used with any UCP routine.

The destroy process releases and shuts down all resources associated with the worker.

Parameters

in	*worker*	Worker object to destroy.

Examples:

ucp_client_server.c, and ucp_hello_world.c.

6.3.5.3 ucp_worker_query()

```
ucs_status_t ucp_worker_query (
             ucp_worker_h worker,
             ucp_worker_attr_t * attr )
```

This routine fetches information about the worker.

Parameters

in	*worker*	Worker object to query.
out	*attr*	Filled with attributes of worker.

Returns

Error code as defined by ucs_status_t

Examples:

ucp_hello_world.c.

6.3.5.4 ucp_worker_print_info()

```
void ucp_worker_print_info (
             ucp_worker_h worker,
             FILE * stream )
```

This routine prints information about the protocols being used, thresholds, UCT transport methods, and other useful information associated with the worker.

Parameters

in	*worker*	Worker object to print information for.
in	*stream*	Output stream to print the information to.

6.3.5.5 ucp_worker_release_address()

```
void ucp_worker_release_address (
            ucp_worker_h worker,
            ucp_address_t * address )
```

This routine release an address handle associated within the worker object.

Warning

Once the address released the address handle cannot be used with any UCP routine.

Parameters

in	*worker*	Worker object that is associated with the address object.
in	*address*	Address to release; the address object has to be allocated using ucp_worker_query() routine.

Examples:

ucp_hello_world.c.

6.3.5.6 ucp_worker_address_query()

```
ucs_status_t ucp_worker_address_query (
            ucp_address_t * address,
            ucp_worker_address_attr_t * attr )
```

This routine fetches information about the worker address. The address can be either of local or remote worker.

Parameters

in	*address*	Worker address to query.
out	*attr*	Filled with attributes of the worker address.

Returns

Error code as defined by ucs_status_t.

6.3.5.7 ucp_worker_progress()

```
unsigned ucp_worker_progress (
            ucp_worker_h worker )
```

This routine explicitly progresses all communication operations on a worker.

Note

- Typically, request wait and test routines call this routine to progress any outstanding operations.
- Transport layers, implementing asynchronous progress using threads, require callbacks and other user code to be thread safe.
- The state of communication can be advanced (progressed) by blocking routines. Nevertheless, the non-blocking routines can not be used for communication progress.

Parameters

in	*worker*	Worker to progress.

Returns

Non-zero if any communication was progressed, zero otherwise.

Examples:

ucp_client_server.c, and ucp_hello_world.c.

6.3.5.8 ucp_stream_worker_poll()

```
ssize_t ucp_stream_worker_poll (
            ucp_worker_h worker,
            ucp_stream_poll_ep_t * poll_eps,
            size_t max_eps,
            unsigned flags )
```

This non-blocking routine returns endpoints on a worker which are ready to consume streaming data. The ready endpoints are placed in *poll_eps* array, and the function return value indicates how many are there.

Parameters

in	*worker*	Worker to poll.
out	*poll_eps*	Pointer to array of endpoints, should be allocated by user.
in	*max_eps*	Maximum number of endpoints that should be filled in *poll_eps*.
in	*flags*	Reserved for future use.

Returns

Negative value indicates an error according to ucs_status_t. On success, non-negative value (less or equal *max_eps*) indicates actual number of endpoints filled in *poll_eps* array.

6.3.5.9 ucp_listener_create()

```
ucs_status_t ucp_listener_create (
            ucp_worker_h worker,
            const ucp_listener_params_t * params,
            ucp_listener_h * listener_p )
```

This routine creates a new listener object that is bound to a specific local address. The listener will listen to incoming connection requests. After receiving a request from the remote peer, an endpoint to this peer will be created - either right away or by calling ucp_ep_create, as specified by the callback type in ucp_listener_params_t. The user's callback will be invoked once the endpoint is created.

Parameters

in	*worker*	Worker object to create the listener on.
in	*params*	User defined ucp_listener_params_t configurations for the ucp_listener_h.

Parameters

out	*listener←↩ _p*	A handle to the created listener, can be released by calling ucp_listener_destroy

Returns

Error code as defined by ucs_status_t

Note

ucp_listener_params_t::conn_handler or ucp_listener_params_t::accept_handler must be provided to be able to handle incoming connections.

Examples:

ucp_client_server.c.

6.3.5.10 ucp_listener_destroy()

```
void ucp_listener_destroy (
            ucp_listener_h listener )
```

This routine unbinds the worker from the given handle and stops listening for incoming connection requests on it.

Parameters

in	*listener*	A handle to the listener to stop listening on.

Examples:

ucp_client_server.c.

6.3.5.11 ucp_listener_query()

```
ucs_status_t ucp_listener_query (
            ucp_listener_h listener,
            ucp_listener_attr_t * attr )
```

This routine fetches information about the listener.

Parameters

in	*listener*	listener object to query.
out	*attr*	Filled with attributes of the listener.

Returns

Error code as defined by ucs_status_t

Examples:

ucp_client_server.c.

6.3.5.12 ucp_conn_request_query()

```
ucs_status_t ucp_conn_request_query (
            ucp_conn_request_h conn_request,
            ucp_conn_request_attr_t * attr )
```

This routine fetches information about the connection request.

Parameters

in	*conn_request*	connection request object to query.
out	*attr*	Filled with attributes of the connection request.

Returns

Error code as defined by ucs_status_t

Examples:

ucp_client_server.c.

6.3.5.13 ucp_listener_reject()

```
ucs_status_t ucp_listener_reject (
            ucp_listener_h listener,
            ucp_conn_request_h conn_request )
```

Reject the incoming connection request and release associated resources. If the remote initiator endpoint has set an ucp_ep_params_t::err_handler, it will be invoked with status UCS_ERR_REJECTED.

Parameters

in	*listener*	Handle to the listener on which the connection request was received.
in	*conn_request*	Handle to the connection request to reject.

Returns

Error code as defined by ucs_status_t

Examples:

ucp_client_server.c.

6.3.5.14 ucp_worker_set_am_recv_handler()

```
ucs_status_t ucp_worker_set_am_recv_handler (
            ucp_worker_h worker,
            const ucp_am_handler_param_t * param )
```

This routine installs a user defined callback to handle incoming Active Messages with a specific id. This callback is called whenever an Active Message that was sent from the remote peer by ucp_am_send_nbx is received on this worker.

Warning

Handlers set by this function are not compatible with ucp_am_send_nb routine.

Parameters

in	*worker*	UCP worker on which to set the Active Message handler.
in	*param*	Active Message handler parameters, as defined by ucp_am_handler_param_t.

Returns

error code if the worker does not support Active Messages or requested callback flags.

Examples:

ucp_client_server.c.

6.3.5.15 ucp_worker_fence()

```
ucs_status_t ucp_worker_fence (
            ucp_worker_h worker )
```

This routine ensures ordering of non-blocking communication operations on the UCP worker. Communication operations issued on a particular endpoint created on the *worker* prior to this call are guaranteed to be completed before any communication operations issued on the same endpoint after this call.

Note

The primary difference between ucp_worker_fence() and the ucp_worker_flush_nb() is the fact the fence routine does not guarantee completion of the operations on the call return but only ensures the order between communication operations. The flush operation on return guarantees that all operations are completed and corresponding memory regions were updated.

Parameters

in	*worker*	UCP worker.

Returns

Error code as defined by ucs_status_t

6.3.5.16 ucp_worker_flush_nbx()

```
ucs_status_ptr_t ucp_worker_flush_nbx (
            ucp_worker_h worker,
            const ucp_request_param_t * param )
```

This routine flushes all outstanding AMO and RMA communications on the worker. All the AMO and RMA operations issued on the *worker* prior to this call are completed both at the origin and at the target when this call returns.

Note

For description of the differences between flush and fence operations please see ucp_worker_fence()

Parameters

in	*worker*	UCP worker.
in	*param*	Operation parameters, see ucp_request_param_t

Returns

NULL - The flush operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The flush operation failed.
otherwise - Flush operation was scheduled and can be completed in any point in time. The request handle is returned to the application in order to track progress.

6.3.5.17 ucp_worker_flush()

```
ucs_status_t ucp_worker_flush (
            ucp_worker_h worker )
```

Deprecated Replaced by ucp_worker_flush_nb. The following example implements the same functionality using ucp_worker_flush_nb :

```
ucs_status_t worker_flush(ucp_worker_h worker)
{
    void *request = ucp_worker_flush_nb(worker);
    if (request == NULL) {
        return UCS_OK;
    } else if (UCS_PTR_IS_ERR(request)) {
        return UCS_PTR_STATUS(request);
    } else {
        ucs_status_t status;
        do {
            ucp_worker_progress(worker);
            status = ucp_request_check_status(request);
        } while (status == UCS_INPROGRESS);
        ucp_request_release(request);
        return status;
    }
}
```

This routine flushes all outstanding AMO and RMA communications on the worker. All the AMO and RMA operations issued on the *worker* prior to this call are completed both at the origin and at the target when this call returns.

Note

For description of the differences between flush and fence operations please see ucp_worker_fence()

Parameters

in	*worker*	UCP worker.

Returns

Error code as defined by ucs_status_t

6.3.5.18 ucp_worker_get_address()

```
ucs_status_t ucp_worker_get_address (
             ucp_worker_h worker,
             ucp_address_t ** address_p,
             size_t * address_length_p )
```

Deprecated Use ucp_worker_query with the flag UCP_WORKER_ATTR_FIELD_ADDRESS in order to obtain the worker address.

This routine returns the address of the worker object. This address can be passed to remote instances of the UCP library in order to connect to this worker. The memory for the address handle is allocated by this function, and must be released by using ucp_worker_release_address() routine.

Parameters

in	*worker*	Worker object whose address to return.
out	*address_p*	A pointer to the worker address.
out	*address_length↩ _p*	The size in bytes of the address.

Returns

Error code as defined by ucs_status_t

6.3.5.19 ucp_worker_set_am_handler()

```
ucs_status_t ucp_worker_set_am_handler (
             ucp_worker_h worker,
             uint16_t id,
             ucp_am_callback_t cb,
             void * arg,
             uint32_t flags )
```

Deprecated Use ucp_worker_set_am_recv_handler instead.

This routine installs a user defined callback to handle incoming Active Messages with a specific id. This callback is called whenever an Active Message that was sent from the remote peer by ucp_am_send_nb is received on this worker.

Parameters

in	*worker*	UCP worker on which to set the Active Message handler.
in	*id*	Active Message id.
in	*cb*	Active Message callback. NULL to clear.
in	*arg*	Active Message argument, which will be passed in to every invocation of the callback as the arg argument.
in	*flags*	Dictates how an Active Message is handled on the remote endpoint. Currently only UCP_AM_FLAG_WHOLE_MSG is supported, which indicates the callback will not be invoked until all data has arrived.

Returns

error code if the worker does not support Active Messages or requested callback flags.

6.3.5.20 ucp_worker_flush_nb()

```
ucs_status_ptr_t ucp_worker_flush_nb (
            ucp_worker_h worker,
            unsigned flags,
            ucp_send_callback_t cb )
```

Deprecated Use ucp_worker_flush_nbx instead.

This routine flushes all outstanding AMO and RMA communications on the worker. All the AMO and RMA operations issued on the *worker* prior to this call are completed both at the origin and at the target when this call returns.

Note

For description of the differences between flush and fence operations please see ucp_worker_fence()

Parameters

in	*worker*	UCP worker.
in	*flags*	Flags for flush operation. Reserved for future use.
in	*cb*	Callback which will be called when the flush operation completes.

Returns

NULL - The flush operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The flush operation failed.
otherwise - Flush operation was scheduled and can be completed in any point in time. The request handle is returned to the application in order to track progress. The application is responsible for releasing the handle using ucp_request_free() routine.

6.4 UCP Memory routines

Data Structures

- struct ucp_rkey_compare_params

  Tuning parameters for the comparison function ucp_rkey_compare. More...
- struct ucp_mem_map_params

  Tuning parameters for the UCP memory mapping. More...
- struct ucp_mem_advise_params

  Tuning parameters for the UCP memory advice. More...
- struct ucp_memh_pack_params

  Memory handle pack parameters passed to ucp_memh_pack. More...
- struct ucp_memh_buffer_release_params

  Memory handle release parameters passed to ucp_memh_buffer_release. More...
- struct ucp_mem_attr

  Attributes of the UCP Memory handle, filled by ucp_mem_query function. More...

Typedefs

- typedef struct ucp_rkey_compare_params ucp_rkey_compare_params_t

  Tuning parameters for the comparison function ucp_rkey_compare.
- typedef struct ucp_mem_map_params ucp_mem_map_params_t

  Tuning parameters for the UCP memory mapping.
- typedef enum ucp_mem_advice ucp_mem_advice_t

  list of UCP memory use advice.
- typedef struct ucp_mem_advise_params ucp_mem_advise_params_t

  Tuning parameters for the UCP memory advice.
- typedef struct ucp_memh_pack_params ucp_memh_pack_params_t

  Memory handle pack parameters passed to ucp_memh_pack.
- typedef struct ucp_memh_buffer_release_params ucp_memh_buffer_release_params_t

  Memory handle release parameters passed to ucp_memh_buffer_release.
- typedef struct ucp_rkey ∗ ucp_rkey_h

  UCP Remote memory handle.
- typedef struct ucp_mem ∗ ucp_mem_h

  UCP Memory handle.
- typedef struct ucp_mem_attr ucp_mem_attr_t

  Attributes of the UCP Memory handle, filled by ucp_mem_query function.

Enumerations

- enum ucp_mem_map_params_field {
  UCP_MEM_MAP_PARAM_FIELD_ADDRESS = UCS_BIT(0), UCP_MEM_MAP_PARAM_FIELD_LENGTH
  = UCS_BIT(1), UCP_MEM_MAP_PARAM_FIELD_FLAGS = UCS_BIT(2), UCP_MEM_MAP_PARAM_FIELD_PROT
  = UCS_BIT(3),
  UCP_MEM_MAP_PARAM_FIELD_MEMORY_TYPE = UCS_BIT(4), UCP_MEM_MAP_PARAM_FIELD_EXPORTED_MEMH_
  = UCS_BIT(5) }

  UCP memory mapping parameters field mask.
- enum ucp_mem_advise_params_field { UCP_MEM_ADVISE_PARAM_FIELD_ADDRESS = UCS_BIT(0),
  UCP_MEM_ADVISE_PARAM_FIELD_LENGTH = UCS_BIT(1), UCP_MEM_ADVISE_PARAM_FIELD_ADVICE
  = UCS_BIT(2) }

  UCP memory advice parameters field mask.

- enum {
  UCP_MEM_MAP_NONBLOCK = UCS_BIT(0), UCP_MEM_MAP_ALLOCATE = UCS_BIT(1), UCP_MEM_MAP_FIXED = UCS_BIT(2), UCP_MEM_MAP_SYMMETRIC_RKEY = UCS_BIT(3),
  UCP_MEM_MAP_LOCK = UCS_BIT(4) }

  UCP memory mapping flags.
- enum { UCP_MEM_MAP_PROT_LOCAL_READ = UCS_BIT(0), UCP_MEM_MAP_PROT_LOCAL_WRITE = UCS_BIT(1), UCP_MEM_MAP_PROT_REMOTE_READ = UCS_BIT(8), UCP_MEM_MAP_PROT_REMOTE_WRITE = UCS_BIT(9) }

  UCP memory mapping protection mode.
- enum ucp_mem_advice { UCP_MADV_NORMAL = 0, UCP_MADV_WILLNEED }

  list of UCP memory use advice.
- enum ucp_memh_pack_params_field { UCP_MEMH_PACK_PARAM_FIELD_FLAGS = UCS_BIT(0) }

  UCP memory handle packing parameters field mask.
- enum ucp_memh_pack_flags { UCP_MEMH_PACK_FLAG_EXPORT = UCS_BIT(0) }

  UCP memory handle flags.
- enum ucp_mem_attr_field { UCP_MEM_ATTR_FIELD_ADDRESS = UCS_BIT(0), UCP_MEM_ATTR_FIELD_LENGTH = UCS_BIT(1), UCP_MEM_ATTR_FIELD_MEM_TYPE = UCS_BIT(2) }

  UCP Memory handle attributes field mask.

Functions

- ucs_status_t ucp_rkey_compare (ucp_worker_h worker, ucp_rkey_h rkey1, ucp_rkey_h rkey2, const ucp_rkey_compare_params_t ∗params, int ∗result)

  Compare two remote keys.
- ucs_status_t ucp_mem_map (ucp_context_h context, const ucp_mem_map_params_t ∗params, ucp_mem_h ∗memh_p)

  Map or allocate memory for zero-copy operations.
- ucs_status_t ucp_mem_unmap (ucp_context_h context, ucp_mem_h memh)

  Unmap memory segment.
- ucs_status_t ucp_mem_query (const ucp_mem_h memh, ucp_mem_attr_t ∗attr)

  query mapped memory segment
- void ucp_mem_print_info (const char ∗mem_spec, ucp_context_h context, FILE ∗stream)

  Print memory mapping information.
- ucs_status_t ucp_mem_advise (ucp_context_h context, ucp_mem_h memh, ucp_mem_advise_params_t ∗params)

  give advice about the use of memory
- ucs_status_t ucp_memh_pack (ucp_mem_h memh, const ucp_memh_pack_params_t ∗params, void ∗∗buffer_p, size_t ∗buffer_size_p)

  Pack a memory handle to a buffer specified by the user.
- void ucp_memh_buffer_release (void ∗buffer, const ucp_memh_buffer_release_params_t ∗params)

  Release packed memory handle buffer.
- ucs_status_t ucp_ep_rkey_unpack (ucp_ep_h ep, const void ∗rkey_buffer, ucp_rkey_h ∗rkey_p)

  Create remote access key from packed buffer.
- ucs_status_t ucp_rkey_ptr (ucp_rkey_h rkey, uint64_t raddr, void ∗∗addr_p)

  Get a local pointer to remote memory.
- void ucp_rkey_destroy (ucp_rkey_h rkey)

  Destroy the remote key.
- ucs_status_t ucp_rkey_pack (ucp_context_h context, ucp_mem_h memh, void ∗∗rkey_buffer_p, size_↩
  t ∗size_p)

  Pack memory region remote access key.
- void ucp_rkey_buffer_release (void ∗rkey_buffer)

  Release packed remote key buffer.

6.4.1 Detailed Description

UCP Memory routines

6.4.2 Data Structure Documentation

6.4.2.1 struct ucp_rkey_compare_params

The structure defines the parameters that can be used for UCP library remote keys comparison using ucp_rkey_compare routine.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, must currently be zero. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.

6.4.2.2 struct ucp_mem_map_params

The structure defines the parameters that are used for the UCP memory mapping tuning during the ucp_mem_map routine.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_mem_map_params_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
void *	address	If the address is not NULL, the routine maps (registers) the memory segment pointed to by this address. If the pointer is NULL, the library allocates mapped (registered) memory segment and returns its address in this argument. Therefore, this value is optional. If it's not set (along with its corresponding bit in the field_mask - UCP_MEM_MAP_PARAM_FIELD_ADDRESS), the ucp_mem_map routine will consider address as set to NULL and will allocate memory.
size_t	length	Length (in bytes) to allocate or map (register). This field is mandatory for filling (along with its corresponding bit in the field_mask - UCP_MEM_MAP_PARAM_FIELD_LENGTH). The ucp_mem_map routine will return with an error if the length isn't specified.
unsigned	flags	Allocation flags, e.g. UCP_MEM_MAP_NONBLOCK. This value is optional. If it's not set (along with its corresponding bit in the field_mask - UCP_MEM_MAP_PARAM_FIELD_FLAGS), the ucp_mem_map routine will consider the flags as set to zero.
unsigned	prot	Memory protection mode, e.g. UCP_MEM_MAP_PROT_LOCAL_READ. This value is optional. If it's not set, the ucp_mem_map routine will consider the flags as set to UCP_MEM_MAP_PROT_LOC↩AL_READ|UCP_MEM_MAP_PROT_LOCAL_WRITE|UCP_MEM_MAP_PROT_REMOTE_READ|UCP_MEM_↩MAP_PROT_REMOTE_WRITE.
ucs_memory_type_t	memory_type	

Data Fields

const void ∗	exported_memh_buffer	Exported memory handle buffer as returned by ucp_mem_map function for a memory handle created and packed by ucp_memh_pack with UCP_MEMH_PACK_FLAG_EXPORT flag. If this field is specified for ucp_mem_map function, a resulting memory handle will be a mapping of peer memory instead of local memory. If the field is not set (along with its corresponding bit in the field_mask - UCP_MEM_MAP_PARAM_FIELD_EXPORTED_MEMH_BUFFER), the ucp_mem_map routine will consider the memory handle buffer to be set to NULL by default.

6.4.2.3 struct ucp_mem_advise_params

This structure defines the parameters that are used for the UCP memory advice tuning during the ucp_mem_advise routine.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_mem_advise_params_field. All fields are mandatory. Provides ABI compatibility with respect to adding new fields.
void ∗	address	Memory base address.
size_t	length	Length (in bytes) to allocate or map (register).
ucp_mem_advice_t	advice	Memory use advice ucp_mem_advice

6.4.2.4 struct ucp_memh_pack_params

This structure defines the parameters that are used for packing the UCP memory handle during the ucp_memh_pack routine.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
uint64_t	flags	Flags to control packing of a memory handle.

6.4.2.5 struct ucp_memh_buffer_release_params

This structure defines the parameters that are used for releasing the UCP memory handle buffer during the ucp_memh_buffer_release routine.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure. All fields are mandatory. Provides ABI compatibility with respect to adding new fields.

6.4.2.6 struct ucp_mem_attr

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_mem_attr_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
void *	address	Address of the memory segment.
size_t	length	Size of the memory segment.
ucs_memory_type_t	mem_type	Type of allocated or registered memory

6.4.3 Typedef Documentation

6.4.3.1 ucp_rkey_compare_params_t

```
typedef struct ucp_rkey_compare_params ucp_rkey_compare_params_t
```

The structure defines the parameters that can be used for UCP library remote keys comparison using ucp_rkey_compare routine.

6.4.3.2 ucp_mem_map_params_t

```
typedef struct ucp_mem_map_params ucp_mem_map_params_t
```

The structure defines the parameters that are used for the UCP memory mapping tuning during the ucp_mem_map routine.

6.4.3.3 ucp_mem_advice_t

```
typedef enum ucp_mem_advice ucp_mem_advice_t
```

The enumeration list describes memory advice supported by ucp_mem_advise() function.

6.4.3.4 ucp_mem_advise_params_t

```
typedef struct ucp_mem_advise_params ucp_mem_advise_params_t
```

This structure defines the parameters that are used for the UCP memory advice tuning during the ucp_mem_advise routine.

6.4.3.5 ucp_memh_pack_params_t

```
typedef struct ucp_memh_pack_params ucp_memh_pack_params_t
```

This structure defines the parameters that are used for packing the UCP memory handle during the ucp_memh_pack routine.

6.4.3.6 ucp_memh_buffer_release_params_t

```
typedef struct ucp_memh_buffer_release_params ucp_memh_buffer_release_params_t
```

This structure defines the parameters that are used for releasing the UCP memory handle buffer during the ucp_memh_buffer_release routine.

6.4.3.7 ucp_rkey_h

```
typedef struct ucp_rkey* ucp_rkey_h
```

Remote memory handle is an opaque object representing remote memory access information. Typically, the handle includes a memory access key and other network hardware specific information, which are input to remote memory access operations, such as PUT, GET, and ATOMIC. The object is communicated to remote peers to enable an access to the memory region.

6.4.3.8 ucp_mem_h

```
typedef struct ucp_mem* ucp_mem_h
```

Memory handle is an opaque object representing a memory region allocated through UCP library, which is optimized for remote memory access operations (zero-copy operations). The memory handle is a self-contained object, which includes the information required to access the memory region locally, while remote key is used to access it remotely. The memory could be registered to one or multiple network resources that are supported by UCP, such as Infini↩ Band, Gemini, and others.

6.4.3.9 ucp_mem_attr_t

```
typedef struct ucp_mem_attr ucp_mem_attr_t
```

6.4.4 Enumeration Type Documentation

6.4.4.1 ucp_mem_map_params_field

```
enum ucp_mem_map_params_field
```

The enumeration allows specifying which fields in ucp_mem_map_params_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_MEM_MAP_PARAM_FIELD_ADDRESS	Address of the memory that will be used in the ucp_mem_map routine.
UCP_MEM_MAP_PARAM_FIELD_LENGTH	The size of memory that will be allocated or registered in the ucp_mem_map routine.
UCP_MEM_MAP_PARAM_FIELD_FLAGS	Allocation flags.
UCP_MEM_MAP_PARAM_FIELD_PROT	Memory protection mode.
UCP_MEM_MAP_PARAM_FIELD_MEMORY_TYPE	Memory type.
UCP_MEM_MAP_PARAM_FIELD_EXPORTED_↩ MEMH_BUFFER	Exported memory handle buffer.

6.4.4.2 ucp_mem_advise_params_field

```
enum ucp_mem_advise_params_field
```

The enumeration allows specifying which fields in ucp_mem_advise_params_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_MEM_ADVISE_PARAM_FIELD_ADDRESS	Address of the memory
UCP_MEM_ADVISE_PARAM_FIELD_LENGTH	The size of memory
UCP_MEM_ADVISE_PARAM_FIELD_ADVICE	Advice on memory usage

6.4.4.3 anonymous enum

`anonymous enum`

The enumeration list describes the memory mapping flags supported by ucp_mem_map() function.

Enumerator

UCP_MEM_MAP_NONBLOCK	Complete the mapping faster, possibly by not populating the pages in the mapping up-front, and mapping them later when they are accessed by communication routines.
UCP_MEM_MAP_ALLOCATE	Identify requirement for allocation, if passed address is not a null-pointer, then it will be used as a hint or direct address for allocation.
UCP_MEM_MAP_FIXED	Don't interpret address as a hint: place the mapping at exactly that address. The address must be a multiple of the page size.
UCP_MEM_MAP_SYMMETRIC_RKEY	Register the memory region so its remote access key would likely be equal to remote access keys received from other peers, when compared with ucp_rkey_compare. This flag is a hint. When remote access keys received from different peers are compared equal, they can be used interchangeably, avoiding the need to keep all of them in memory.
UCP_MEM_MAP_LOCK	Enforce pinning of the memory pages in the mapping and populate them up-front. This flag is mutually exclusive with UCP_MEM_MAP_NONBLOCK.

6.4.4.4 anonymous enum

`anonymous enum`

The enumeration list describes the memory mapping protections supported by the ucp_mem_map() function.

Enumerator

UCP_MEM_MAP_PROT_LOCAL_READ	Enable local read access.
UCP_MEM_MAP_PROT_LOCAL_WRITE	Enable local write access.
UCP_MEM_MAP_PROT_REMOTE_READ	Enable remote read access.
UCP_MEM_MAP_PROT_REMOTE_WRITE	Enable remote write access.

6.4.4.5 ucp_mem_advice

```
enum ucp_mem_advice
```

The enumeration list describes memory advice supported by ucp_mem_advise() function.

Enumerator

UCP_MADV_NORMAL	No special treatment
UCP_MADV_WILLNEED	can be used on the memory mapped with UCP_MEM_MAP_NONBLOCK to speed up memory mapping and to avoid page faults when the memory is accessed for the first time.

6.4.4.6 ucp_memh_pack_params_field

```
enum ucp_memh_pack_params_field
```

The enumeration allows specifying which fields in ucp_memh_pack_params_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_MEMH_PACK_PARAM_FIELD_FLAGS	Memory handle packing field that will be used in the ucp_memh_pack routine.

6.4.4.7 ucp_memh_pack_flags

```
enum ucp_memh_pack_flags
```

The enumeration list describes the memory handle packing flags supported by ucp_memh_pack() function.

Enumerator

UCP_MEMH_PACK_FLAG_EXPORT	Pack a memory handle to be exported and used by peers for their local operations on a memory buffer allocated from same or another virtual memory space, but physically registered on the same network device. A peer should call ucp_mem_map with the flag UCP_MEM_MAP_PARAM_FIELD_EXPORTED_MEMH_BUFFER in order to import and use a memory handle buffer obtained from ucp_memh_pack.

6.4.4.8 ucp_mem_attr_field

```
enum ucp_mem_attr_field
```

The enumeration allows specifying which fields in ucp_mem_attr_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_MEM_ATTR_FIELD_ADDRESS	Virtual address
UCP_MEM_ATTR_FIELD_LENGTH	The size of memory region
UCP_MEM_ATTR_FIELD_MEM_TYPE	Type of allocated or registered memory

6.4.5 Function Documentation

6.4.5.1 ucp_rkey_compare()

```
ucs_status_t ucp_rkey_compare (
            ucp_worker_h worker,
            ucp_rkey_h rkey1,
            ucp_rkey_h rkey2,
            const ucp_rkey_compare_params_t * params,
            int * result )
```

This routine compares two remote keys. They must belong to the same worker.

It sets the *result* argument to < 0 if rkey1 is lower than rkey2, 0 if they are equal or > 0 if rkey1 is greater than rkey2. The result value can be used for sorting remote keys.

Parameters

in	*worker*	Worker object both rkeys are referring to
in	*rkey1*	First rkey to compare
in	*rkey2*	Second rkey to compare
in	*params*	Additional parameters to the comparison
out	*result*	Result of the comparison

Returns

UCS_OK - *result* contains the comparison result
UCS_ERR_INVALID_PARAM - The routine arguments are invalid
Other - Error code as defined by ucs_status_t

6.4.5.2 ucp_mem_map()

```
ucs_status_t ucp_mem_map (
            ucp_context_h context,
            const ucp_mem_map_params_t * params,
            ucp_mem_h * memh_p )
```

This routine maps or/and allocates a user-specified memory segment with UCP application context and the network resources associated with it. If the application specifies NULL as an address for the memory segment, the routine allocates a mapped memory segment and returns its address in the *address_p* argument. The network stack associated with an application context can typically send and receive data from the mapped memory without CPU intervention; some devices and associated network stacks require the memory to be mapped to send and receive data. The memory handle includes all information required to access the memory locally using UCP routines, while remote registration handle provides an information that is necessary for remote memory access.

Note

Another well know terminology for the "map" operation that is typically used in the context of networking is memory "registration" or "pinning". The UCP library registers the memory the available hardware so it can be assessed directly by the hardware.

Memory mapping assumptions:

- A given memory segment can be mapped by several different communication stacks, if these are compatible.
- The *memh_p* handle returned may be used with any sub-region of the mapped memory.
- If a large segment is registered, and then segmented for subsequent use by a user, then the user is responsible for segmentation and subsequent management.

Table 6.77: Matrix of behavior

parameter/flag	NONBLOCK	ALLOCATE	FIXED	address	**result**
value	0/1 - the value only affects the register/map phase	0	0	0	error if length $>$ 0
		1	0	0	alloc+register
		0	1	0	error
		0	0	defined	register
		1	1	0	error
		1	0	defined	alloc+register,hint
		0	1	defined	error
		1	1	defined	alloc+register,fixed

Note

- **register** means that the memory will be registered in corresponding transports for RMA/AMO operations. This case intends that the memory was allocated by user before.
- **alloc+register** means that the memory will be allocated in the memory provided by the system and registered in corresponding transports for RMA/AMO operations.
- **alloc+register,hint** means that the memory will be allocated with using ucp_mem_map_params::address as a hint and registered in corresponding transports for RMA/AMO operations.
- **alloc+register,fixed** means that the memory will be allocated and registered in corresponding transports for RMA/AMO operations.
- **error** is an erroneous combination of the parameters.

Parameters

`in`	*context*	Application context to map (register) and allocate the memory on.
`in`	*params*	User defined ucp_mem_map_params_t configurations for the UCP memory handle.
`out`	*memh←↩ _p*	UCP handle for the allocated segment.

Returns

Error code as defined by ucs_status_t

6.4.5.3 ucp_mem_unmap()

```
ucs_status_t ucp_mem_unmap (
            ucp_context_h context,
            ucp_mem_h memh )
```

This routine unmaps a user specified memory segment, that was previously mapped using the ucp_mem_map() routine. The unmap routine will also release the resources associated with the memory handle. When the function returns, the ucp_mem_h and associated remote key will be invalid and cannot be used with any UCP routine.

Note

Another well know terminology for the "unmap" operation that is typically used in the context of networking is memory "de-registration". The UCP library de-registers the memory the available hardware so it can be returned back to the operation system.

Error cases:

- Once memory is unmapped a network access to the region may cause a failure.

Parameters

in	*context*	Application context which was used to allocate/map the memory.
in	*memh*	Handle to memory region.

Returns

Error code as defined by ucs_status_t

6.4.5.4 ucp_mem_query()

```
ucs_status_t ucp_mem_query (
            const ucp_mem_h memh,
            ucp_mem_attr_t * attr )
```

This routine returns address and length of memory segment mapped with ucp_mem_map() routine.

Parameters

in	*memh*	Handle to memory region.
out	*attr*	Filled with attributes of the UCP memory handle.

Returns

Error code as defined by ucs_status_t

6.4.5.5 ucp_mem_print_info()

```
void ucp_mem_print_info (
            const char * mem_spec,
            ucp_context_h context,
            FILE * stream )
```

This routine maps memory and prints information about the created memory handle: including the mapped memory length, the allocation method, and other useful information associated with the memory handle.

Parameters

in	*mem_spec*	Size and optional type of the memory to map. The format of the string is: "<size>[,<type>]". For example: • "32768" : allocate 32 kilobytes of host memory. • "1m,cuda" : allocate 1 megabyte of cuda memory.
in	*context*	The context on which the memory is mapped.
in	*stream*	Output stream on which to print the information.

6.4.5.6 ucp_mem_advise()

```
ucs_status_t ucp_mem_advise (
            ucp_context_h context,
            ucp_mem_h memh,
            ucp_mem_advise_params_t * params )
```

This routine advises the UCP about how to handle memory range beginning at address and size of length bytes. This call does not influence the semantics of the application, but may influence its performance. The UCP may ignore the advice.

Parameters

in	*context*	Application context which was used to allocate/map the memory.
in	*memh*	Handle to memory region.
in	*params*	Memory base address and length. The advice field is used to pass memory use advice as defined in the ucp_mem_advice list The memory range must belong to the *memh*

Returns

Error code as defined by ucs_status_t

6.4.5.7 ucp_memh_pack()

```
ucs_status_t ucp_memh_pack (
            ucp_mem_h memh,
            const ucp_memh_pack_params_t * params,
            void ** buffer_p,
            size_t * buffer_size_p )
```

This routine allocates a memory buffer and packs a memory handle into the buffer. A packed memory key is an opaque object that provides the information that is necessary for a peer. This routine packs the memory handle in a portable format such that the object can be unpacked on any platform supported by the UCP library, e.g. if the memory handle was packed as a remote memory key (RKEY), it should be unpacked by ucp_ep_rkey_unpack(). In order to release the memory buffer allocated by this routine, the application is responsible for calling the ucp_memh_buffer_release() routine.

Note

- RKEYs for InfiniBand and Cray Aries networks typically includes InfiniBand and Aries key.
- In order to enable remote direct memory access to the memory associated with the memory handle the application is responsible for sharing the RKEY with the peers that will initiate the access.

Parameters

in	*memh*	Handle to memory region.
in	*params*	Memory handle packing parameters, as defined by ucp_memh_pack_params_t.
out	*buffer_p*	Memory buffer allocated by the library. The buffer contains the packed memory handle.
out	*buffer_size↩_p*	Size (in bytes) of the buffer which contains packed memory handle.

Returns

Error code as defined by ucs_status_t

6.4.5.8 ucp_memh_buffer_release()

```
void ucp_memh_buffer_release (
            void * buffer,
            const ucp_memh_buffer_release_params_t * params )
```

This routine releases the buffer that was allocated using ucp_memh_pack().

Warning

- Once memory is released, an access to the memory may cause undefined behavior.
- If the input memory address was not allocated using ucp_memh_pack() routine, the behavior of this routine is undefined.

Parameters

in	*buffer*	Buffer to release.
in	*params*	Memory handle buffer release parameters, as defined by ucp_memh_buffer_release_params_t.

6.4.5.9 ucp_ep_rkey_unpack()

```
ucs_status_t ucp_ep_rkey_unpack (
            ucp_ep_h ep,
            const void * rkey_buffer,
            ucp_rkey_h * rkey_p )
```

This routine unpacks the remote key (RKEY) object into the local memory such that it can be accessed and used by UCP routines. The RKEY object has to be packed using the ucp_rkey_pack() routine. Application code should not make any changes to the content of the RKEY buffer.

Note

The application is responsible for releasing the RKEY object when it is no longer needed, by calling the ucp_rkey_destroy() routine.
The remote key object can be used for communications only on the endpoint on which it was unpacked.

Parameters

in	*ep*	Endpoint to access using the remote key.
in	*rkey_buffer*	Packed rkey.
out	*rkey_p*	Remote key handle.

Returns

Error code as defined by ucs_status_t

6.4.5.10 ucp_rkey_ptr()

```
ucs_status_t ucp_rkey_ptr (
             ucp_rkey_h rkey,
             uint64_t raddr,
             void ** addr_p )
```

This routine returns a local pointer to the remote memory described by the rkey.

Note

This routine can return a valid pointer only for the endpoints that are reachable via shared memory.

Parameters

in	*rkey*	A remote key handle.
in	*raddr*	A remote memory address within the memory area described by the rkey.
out	*addr↩_p*	A pointer that can be used for direct access to the remote memory.

Returns

Error code as defined by ucs_status_t if the remote memory cannot be accessed directly or the remote memory address is not valid.

6.4.5.11 ucp_rkey_destroy()

```
void ucp_rkey_destroy (
             ucp_rkey_h rkey )
```

This routine destroys the RKEY object and the memory that was allocated using the ucp_ep_rkey_unpack() routine. This routine also releases any resources that are associated with the RKEY object.

Warning

- Once the RKEY object is released an access to the memory will cause an undefined failure.
- If the RKEY object was not created using ucp_ep_rkey_unpack() routine the behavior of this routine is undefined.
- The RKEY object must be destroyed after all outstanding operations which are using it are flushed, and before the endpoint on which it was unpacked is destroyed.

Parameters

in	*rkey*	Remote key to destroy.

6.4.5.12 ucp_rkey_pack()

```
ucs_status_t ucp_rkey_pack (
             ucp_context_h context,
             ucp_mem_h memh,
             void ** rkey_buffer_p,
             size_t * size_p )
```

Deprecated Replaced by ucp_memh_pack().

This routine allocates a memory buffer and packs a remote access key (RKEY) object into it. RKEY is an opaque object that provides the information that is necessary for remote memory access. This routine packs the R↩ KEY object in a portable format such that the object can be unpacked on any platform supported by the UCP library. In order to release the memory buffer allocated by this routine, the application is responsible for calling the ucp_rkey_buffer_release() routine.

Note

- RKEYs for InfiniBand and Cray Aries networks typically include the InfiniBand and Aries key.
- In order to enable remote direct memory access to the memory associated with the memory handle, the application is responsible for sharing the RKEY with the peers that will initiate the access.

Parameters

in	*context*	Application context which was used to allocate/map the memory.
in	*memh*	Handle to the memory region.
out	*rkey_buffer↩ _p*	Memory buffer allocated by the library. The buffer contains the packed RKEY.
out	*size_p*	Size (in bytes) of the packed RKEY.

Returns

Error code as defined by ucs_status_t

6.4.5.13 ucp_rkey_buffer_release()

```
void ucp_rkey_buffer_release (
            void * rkey_buffer )
```

Deprecated Replaced by ucp_memh_buffer_release().

This routine releases the buffer that was allocated using ucp_rkey_pack().

Warning

- Once memory is released, an access to the memory may cause undefined behavior.
- If the input memory address was not allocated using ucp_rkey_pack() routine, the behavior of this routine is undefined.

Parameters

in	*rkey_buffer*	Buffer to release.

6.5 UCP Wake-up routines

Functions

- ucs_status_t ucp_worker_get_efd (ucp_worker_h worker, int ∗fd)

  Obtain an event file descriptor for event notification.
- ucs_status_t ucp_worker_wait (ucp_worker_h worker)

  Wait for an event of the worker.
- void ucp_worker_wait_mem (ucp_worker_h worker, void ∗address)

  Wait for memory update on the address.
- ucs_status_t ucp_worker_arm (ucp_worker_h worker)

  Turn on event notification for the next event.
- ucs_status_t ucp_worker_signal (ucp_worker_h worker)

  Cause an event of the worker.

6.5.1 Detailed Description

UCP Wake-up routines

6.5.2 Function Documentation

6.5.2.1 ucp_worker_get_efd()

```
ucs_status_t ucp_worker_get_efd (
            ucp_worker_h worker,
            int ∗ fd )
```

This routine returns a valid file descriptor for polling functions. The file descriptor will get signaled when an event occurs, as part of the wake-up mechanism. Signaling means a call to poll() or select() with this file descriptor will return at this point, with this descriptor marked as the reason (or one of the reasons) the function has returned. The user does not need to release the obtained file descriptor.

The wake-up mechanism exists to allow for the user process to register for notifications on events of the underlying interfaces, and wait until such occur. This is an alternative to repeated polling for request completion. The goal is to allow for waiting while consuming minimal resources from the system. This is recommended for cases where traffic is infrequent, and latency can be traded for lower resource consumption while waiting for it.

There are two alternative ways to use the wakeup mechanism: the first is the file descriptor obtained per worker (this function) and the second is the ucp_worker_wait function for waiting on the next event internally.

Note

UCP features have to be triggered with UCP_FEATURE_WAKEUP to select proper transport

Parameters

in	*worker*	Worker of notified events.
out	*fd*	File descriptor.

Returns

Error code as defined by ucs_status_t

Examples:

ucp_hello_world.c.

6.5.2.2 ucp_worker_wait()

```
ucs_status_t ucp_worker_wait (
            ucp_worker_h worker )
```

This routine waits (blocking) until an event has happened, as part of the wake-up mechanism.

This function is guaranteed to return only if new communication events occur on the *worker*. Therefore one must drain all existing events before waiting on the file descriptor. This can be achieved by calling ucp_worker_progress repeatedly until it returns 0.

There are two alternative ways to use the wakeup mechanism. The first is by polling on a per-worker file descriptor obtained from ucp_worker_get_efd. The second is by using this function to perform an internal wait for the next event associated with the specified worker.

Note

During the blocking call the wake-up mechanism relies on other means of notification and may not progress some of the requests as it would when calling ucp_worker_progress (which is not invoked in that duration). UCP features have to be triggered with UCP_FEATURE_WAKEUP to select proper transport

Parameters

in	*worker*	Worker to wait for events on.

Returns

Error code as defined by ucs_status_t

Examples:

ucp_hello_world.c.

6.5.2.3 ucp_worker_wait_mem()

```
void ucp_worker_wait_mem (
            ucp_worker_h worker,
            void * address )
```

This routine waits for a memory update at the local memory *address*. This is a blocking routine. The routine returns when the memory address is updated ("write") or an event occurs in the system.

This function is guaranteed to return only if new communication events occur on the worker or *address* is modified. Therefore one must drain all existing events before waiting on the file descriptor. This can be achieved by calling ucp_worker_progress repeatedly until it returns 0.

Note

This routine can be used by an application that executes busy-waiting loop checking for a memory update. Instead of continuous busy-waiting on an address the application can use *ucp_worker_wait_mem*, which may suspend execution until the memory is updated. The goal of the routine is to provide an opportunity for energy savings for architectures that support this functionality.

Parameters

in	*worker*	Worker to wait for updates on.
in	*address*	Local memory address

6.5.2.4 ucp_worker_arm()

```
ucs_status_t ucp_worker_arm (
              ucp_worker_h worker )
```

This routine needs to be called before waiting on each notification on this worker, so will typically be called once the processing of the previous event is over, as part of the wake-up mechanism.

The worker must be armed before waiting on an event (must be re-armed after it has been signaled for reuse) with ucp_worker_arm. The events triggering a signal of the file descriptor from ucp_worker_get_efd depend on the interfaces used by the worker and defined in the transport layer, and typically represent a request completion or newly available resources. It can also be triggered by calling ucp_worker_signal .

The file descriptor is guaranteed to become signaled only if new communication events occur on the *worker*. Therefore one must drain all existing events before waiting on the file descriptor. This can be achieved by calling ucp_worker_progress repeatedly until it returns 0.

```
void application_initialization() {
// should be called once in application init flow and before
// process_communication() is used
    ...
    status = ucp_worker_get_efd(worker, &fd);
    ...
}

void process_communication() {
// should be called every time need to wait for some condition such as
// ucp request completion in sleep mode.

    for (;;) {
        // check for stop condition as long as progress is made
        if (check_for_events()) {
             break;
        } else if (ucp_worker_progress(worker)) {
             continue;                 // some progress happened but condition not met
        }

        // arm the worker and clean-up fd
        status = ucp_worker_arm(worker);
        if (UCS_OK == status) {
            poll(&fds, nfds, timeout);  // wait for events (sleep mode)
        } else if (UCS_ERR_BUSY == status) {
            continue;                   // could not arm, need to progress more
        } else {
            abort();
        }
    }
}
```

Note

UCP features have to be triggered with UCP_FEATURE_WAKEUP to select proper transport

Parameters

in	*worker*	Worker of notified events.

Returns

UCS_OK The operation completed successfully. File descriptor will be signaled by new events.
UCS_ERR_BUSY There are unprocessed events which prevent the file descriptor from being armed. These events should be removed by calling ucp_worker_progress(). The operation is not completed. File descriptor will not be signaled by new events.
Other different error codes in case of issues.

Examples:

ucp_hello_world.c.

6.5.2.5 ucp_worker_signal()

```
ucs_status_t ucp_worker_signal (
            ucp_worker_h worker )
```

This routine signals that the event has happened, as part of the wake-up mechanism. This function causes a blocking call to ucp_worker_wait or waiting on a file descriptor from ucp_worker_get_efd to return, even if no event from the underlying interfaces has taken place.

Note

It's safe to use this routine from any thread, even if UCX is compiled without multi-threading support and/or initialized with any value of ucp_params_t::mt_workers_shared and ucp_worker_params_t::thread_mode parameters

Parameters

in	*worker*	Worker to wait for events on.

Returns

Error code as defined by ucs_status_t

6.6 UCP Endpoint

Data Structures

- struct ucp_ep_evaluate_perf_param_t

  UCP endpoint performance evaluation request attributes. More...
- struct ucp_ep_evaluate_perf_attr_t

  UCP endpoint performance evaluation result attributes. More...
- struct ucp_stream_poll_ep

  Output parameter of ucp_stream_worker_poll function. More...
- struct ucp_ep_attr

  UCP endpoint attributes. More...
- struct ucp_ep_params

  Tuning parameters for the UCP endpoint. More...
- struct ucp_transport_entry_t

  The ucp_transports_t and ucp_transport_entry_t structures are used when ucp_ep_query is called to return an array of transport name and device name pairs that are used by an active endpoint. More...
- struct ucp_transports_t

  Structure containing an array of transport layers and device names used by an endpoint. More...

Typedefs

- typedef enum ucp_ep_perf_param_field ucp_ep_perf_param_field_t

  UCP performance fields and flags.
- typedef enum ucp_ep_perf_attr_field ucp_ep_perf_attr_field_t

  UCP performance fields and flags.
- typedef struct ucp_stream_poll_ep ucp_stream_poll_ep_t

  Output parameter of ucp_stream_worker_poll function.
- typedef struct ucp_ep_attr ucp_ep_attr_t

  UCP endpoint attributes.
- typedef struct ucp_ep ∗ ucp_ep_h

  UCP Endpoint.
- typedef struct ucp_conn_request ∗ ucp_conn_request_h

  UCP connection request.
- typedef ucs_status_t(∗ ucp_am_callback_t) (void ∗arg, void ∗data, size_t length, ucp_ep_h reply_ep, unsigned flags)

  Callback to process incoming Active Message.
- typedef ucs_status_t(∗ ucp_am_recv_callback_t) (void ∗arg, const void ∗header, size_t header_length, void ∗data, size_t length, const ucp_am_recv_param_t ∗param)

  Callback to process incoming Active Message sent by ucp_am_send_nbx routine.
- typedef struct ucp_ep_params ucp_ep_params_t

  Tuning parameters for the UCP endpoint.

Enumerations

- enum ucp_ep_params_field {
  UCP_EP_PARAM_FIELD_REMOTE_ADDRESS = UCS_BIT(0), UCP_EP_PARAM_FIELD_ERR_HANDLING_MODE = UCS_BIT(1), UCP_EP_PARAM_FIELD_ERR_HANDLER = UCS_BIT(2), UCP_EP_PARAM_FIELD_USER_DATA = UCS_BIT(3),
  UCP_EP_PARAM_FIELD_SOCK_ADDR = UCS_BIT(4), UCP_EP_PARAM_FIELD_FLAGS = UCS_BIT(5), UCP_EP_PARAM_FIELD_CONN_REQUEST = UCS_BIT(6), UCP_EP_PARAM_FIELD_NAME = UCS_↩
  BIT(7),
  UCP_EP_PARAM_FIELD_LOCAL_SOCK_ADDR = UCS_BIT(8) }

UCP endpoint parameters field mask.

- enum ucp_ep_params_flags_field { UCP_EP_PARAMS_FLAGS_CLIENT_SERVER = UCS_BIT(0), UCP_EP_PARAMS_FLAGS_NO_LOOPBACK = UCS_BIT(1), UCP_EP_PARAMS_FLAGS_SEND_CLIENT_ID = UCS_BIT(2) }

  UCP endpoint parameters flags.
- enum ucp_ep_close_flags_t { UCP_EP_CLOSE_FLAG_FORCE = UCS_BIT(0) }

  Close UCP endpoint modes.
- enum ucp_ep_perf_param_field { UCP_EP_PERF_PARAM_FIELD_MESSAGE_SIZE = UCS_BIT(0) }

  UCP performance fields and flags.
- enum ucp_ep_perf_attr_field { UCP_EP_PERF_ATTR_FIELD_ESTIMATED_TIME = UCS_BIT(0) }

  UCP performance fields and flags.
- enum ucp_cb_param_flags { UCP_CB_PARAM_FLAG_DATA = UCS_BIT(0) }

  Descriptor flags for Active Message callback.
- enum ucp_ep_attr_field {
  UCP_EP_ATTR_FIELD_NAME = UCS_BIT(0), UCP_EP_ATTR_FIELD_LOCAL_SOCKADDR = UCS_B←
  IT(1), UCP_EP_ATTR_FIELD_REMOTE_SOCKADDR = UCS_BIT(2), UCP_EP_ATTR_FIELD_TRANSPORTS = UCS_BIT(3),
  UCP_EP_ATTR_FIELD_USER_DATA = UCS_BIT(4) }

  UCP endpoint attributes field mask.
- enum ucp_ep_close_mode { UCP_EP_CLOSE_MODE_FORCE = 0, UCP_EP_CLOSE_MODE_FLUSH = 1 }

  Close UCP endpoint modes.
- enum ucp_err_handling_mode_t { UCP_ERR_HANDLING_MODE_NONE, UCP_ERR_HANDLING_MODE_PEER }

  Error handling mode for the UCP endpoint.

Functions

- ucs_status_t ucp_ep_create (ucp_worker_h worker, const ucp_ep_params_t ∗params, ucp_ep_h ∗ep_p)

  Create and connect an endpoint.
- ucs_status_ptr_t ucp_ep_close_nbx (ucp_ep_h ep, const ucp_request_param_t ∗param)

  Non-blocking endpoint closure.
- void ucp_ep_print_info (ucp_ep_h ep, FILE ∗stream)

  Print endpoint information.
- ucs_status_ptr_t ucp_ep_flush_nbx (ucp_ep_h ep, const ucp_request_param_t ∗param)

  Non-blocking flush of outstanding AMO and RMA operations on the endpoint.
- ucs_status_t ucp_ep_evaluate_perf (ucp_ep_h ep, const ucp_ep_evaluate_perf_param_t ∗param, ucp_ep_evaluate_perf_attr_t ∗attr)

  Estimate performance characteristics of a specific endpoint.
- ucs_status_t ucp_ep_query (ucp_ep_h ep, ucp_ep_attr_t ∗attr)

  Get attributes of a given endpoint.
- void ucp_request_release (void ∗request)
- void ucp_ep_destroy (ucp_ep_h ep)
- ucs_status_ptr_t ucp_disconnect_nb (ucp_ep_h ep)
- ucs_status_t ucp_request_test (void ∗request, ucp_tag_recv_info_t ∗info)
- ucs_status_t ucp_ep_flush (ucp_ep_h ep)
- ucs_status_ptr_t ucp_ep_modify_nb (ucp_ep_h ep, const ucp_ep_params_t ∗params)

  Modify endpoint parameters.
- ucs_status_ptr_t ucp_ep_close_nb (ucp_ep_h ep, unsigned mode)

  Non-blocking endpoint closure.
- ucs_status_ptr_t ucp_ep_flush_nb (ucp_ep_h ep, unsigned flags, ucp_send_callback_t cb)

  Non-blocking flush of outstanding AMO and RMA operations on the endpoint.

6.6.1 Detailed Description

UCP Endpoint routines

6.6.2 Data Structure Documentation

6.6.2.1 struct ucp_ep_evaluate_perf_param_t

The structure defines the attributes which characterize the request for performance estimation of a particular endpoint.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_ep_perf_param_field_t. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
size_t	message_size	Message size to use for determining performance. This field must be initialized by the caller.

6.6.2.2 struct ucp_ep_evaluate_perf_attr_t

The structure defines the attributes which characterize the result of performance estimation of a particular endpoint.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_ep_perf_attr_field_t. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
double	estimated_time	Estimated time (in seconds) required to send a message of a given size on this endpoint. This field is set by the ucp_ep_evaluate_perf function.

6.6.2.3 struct ucp_stream_poll_ep

The structure defines the endpoint and its user data.

Data Fields

ucp_ep_h	ep	Endpoint handle.
void ∗	user_data	User data associated with an endpoint passed in ucp_ep_params_t::user_data.
unsigned	flags	Reserved for future use.
uint8_t	reserved[16]	Reserved for future use.

6.6.2.4 struct ucp_ep_attr

The structure defines the attributes that characterize the particular endpoint.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_ep_attr_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
char	name[UCP_ENTITY_NAME_MAX]	Endpoint name. Tracing and analysis tools can identify the endpoint using this name.
struct sockaddr_storage	local_sockaddr	Local socket address for this endpoint. Valid only for endpoints created by connecting to a socket address. If this field is specified for an endpoint not connected to a socket address, UCS_ERR_NOT_CONNECTED will be returned.
struct sockaddr_storage	remote_sockaddr	Remote socket address this endpoint is connected to. Valid only for endpoints created by connecting to a socket address. If this field is specified for an endpoint not connected to a socket address, UCS_ERR_NOT_CONNECTED will be returned.
ucp_transports_t	transports	Structure defining an array containing transport and device names used by this endpoint. The caller is responsible for allocation and deallocation of this array.
void ∗	user_data	User data associated with an endpoint passed in ucp_ep_params_t::user_data.

6.6.2.5 struct ucp_ep_params

The structure defines the parameters that are used for the UCP endpoint tuning during the UCP ep creation.

Examples:

ucp_client_server.c, and ucp_hello_world.c.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_ep_params_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
const ucp_address_t ∗	address	Destination address; this field should be set along with its corresponding bit in the field_mask - UCP_EP_PARAM_FIELD_REMOTE_ADDRESS and must be obtained using ucp_worker_get_address.
ucp_err_handling_mode_t	err_mode	Desired error handling mode, optional parameter. Default value is UCP_ERR_HANDLING_MODE_NONE.
ucp_err_handler_t	err_handler	Handler to process transport level failure.
void ∗	user_data	User data associated with an endpoint. See ucp_stream_poll_ep_t and ucp_err_handler_t
unsigned	flags	Endpoint flags from ucp_ep_params_flags_field. This value is optional. If it's not set (along with its corresponding bit in the field_mask - UCP_EP_PARAM_FIELD_FLAGS), the ucp_ep_create() routine will consider the flags as set to zero.

Data Fields

ucs_sock_addr_t	sockaddr	Destination address in the form of a sockaddr; this field should be set along with its corresponding bit in the field_mask - UCP_EP_PARAM_FIELD_SOCK_ADDR and must be obtained from the user, it means that this type of the endpoint creation is possible only on client side in client-server connection establishment flow.
ucp_conn_request_h	conn_request	Connection request from client; this field should be set along with its corresponding bit in the field_mask - UCP_EP_PARAM_FIELD_CONN_REQUEST and must be obtained from ucp_listener_conn_callback_t, it means that this type of the endpoint creation is possible only on server side in client-server connection establishment flow.
const char ∗	name	Endpoint name. Tracing and analysis tools can identify the endpoint using this name. To retrieve the endpoint's name, use ucp_ep_query, as the name you supply may be changed by UCX under some circumstances, e.g. a name conflict. This field is only assigned if you set UCP_EP_PARAM_FIELD_NAME in the field mask. If not, then a default unique name will be created for you.
ucs_sock_addr_t	local_sockaddr	The sockaddr to bind locally. Specifies the associated network device to bind locally to establish new connections. To retrieve the endpoint's local_sockaddr, use ucp_ep_query. This setting is optional. To enable it, the corresponding - UCP_EP_PARAM_FIELD_LOCAL_SOCK_ADDR bit in the field mask must be set.

6.6.2.6 struct ucp_transport_entry_t

The ucp_transport_t structure specifies the characteristics of the ucp_transport_entry_t array.

The caller is responsible for the allocation and de-allocation of the ucp_transport_entry_t array.

Example: Implementation of a function to query the set of transport and device name pairs used by the specified endpoint.

```
int query_transports(ucp_ep_h ep)
{
  ucs_status_t status;
  ucp_transport_entry_t *transport_entries;
  ucp_ep_attr_t ep_attrs;

  ep_attrs.field_mask = UCP_EP_ATTR_FIELD_TRANSPORTS;
  ep_attrs.transports.entries = (ucp_transport_entry_t *)
          malloc(10 * sizeof(ucp_transport_entry_t));
  ep_attrs.transports.num_entries = 10;
  ep_attrs.transports.entry_size = sizeof(
      ucp_transport_entry_t);
  status = ucp_ep_query(ep, &ep_attrs);
  if (status == UCS_OK) {
      // ep_attrs.transports.num_entries = number of returned entries
      // ... process transport info ...
  }
}
```

A transport name and device name pair used by this endpoint. The caller is responsible for the allocation and deallocation of an array of these structures large enough to contain the desired number of transport and device name pairs.

Any new fields must be added to the end of this structure.

Data Fields

const char *	transport_name	The name of a transport layer used by this endpoint. This '\0'-terminated string is valid until the endpoint is closed using a ucp_ep_close_nbx call.
const char *	device_name	The name of the device used with this transport by this endpoint. This '\0'-terminated string is valid until the endpoint is closed using a ucp_ep_close_nbx call.

6.6.2.7 struct ucp_transports_t

The caller is responsible for allocation and deallocation of this structure.

Data Fields

ucp_transport_entry_t *	entries	Pointer to array of transport/device name pairs used by this endpoint. The caller is responsible for the allocation and deallocation of this array.
unsigned	num_entries	Number of transport/device name pairs. The caller must set this to the maximum number of pairs the structure can contain. On return, this is set to the actual number of transport and device name pairs used by the endpoint.
size_t	entry_size	Size of a single ucp_transport_entry_t object. The caller sets this to the size of the ucp_transport_entry_t they are using. UCP code must not set any fields in the ucp_transport_entry_t structure beyond this size.

6.6.3 Typedef Documentation

6.6.3.1 ucp_ep_perf_param_field_t

```
typedef enum ucp_ep_perf_param_field ucp_ep_perf_param_field_t
```

The enumeration allows specifying which fields in ucp_ep_evaluate_perf_param_t are present and operation flags are used. It is used to enable backward compatibility support.

6.6.3.2 ucp_ep_perf_attr_field_t

```
typedef enum ucp_ep_perf_attr_field ucp_ep_perf_attr_field_t
```

The enumeration allows specifying which fields in ucp_ep_evaluate_perf_attr_t are present and operation flags are used. It is used to enable backward compatibility support.

6.6.3.3 ucp_stream_poll_ep_t

```
typedef struct ucp_stream_poll_ep ucp_stream_poll_ep_t
```

The structure defines the endpoint and its user data.

6.6.3.4 ucp_ep_attr_t

```
typedef struct ucp_ep_attr ucp_ep_attr_t
```

The structure defines the attributes that characterize the particular endpoint.

6.6.3.5 ucp_ep_h

```
typedef struct ucp_ep* ucp_ep_h
```

The endpoint handle is an opaque object that is used to address a remote worker. It typically provides a description of source, destination, or both. All UCP communication routines address a destination with the endpoint handle. The endpoint handle is associated with only one UCP context. UCP provides the endpoint create routine to create the endpoint handle and the destroy routine to destroy the endpoint handle.

6.6.3.6 ucp_conn_request_h

```
typedef struct ucp_conn_request* ucp_conn_request_h
```

A server-side handle to incoming connection request. Can be used to create an endpoint which connects back to the client.

6.6.3.7 ucp_am_callback_t

```
typedef ucs_status_t(* ucp_am_callback_t) (void *arg, void *data, size_t length, ucp_ep_h reply←
_ep, unsigned flags)
```

When the callback is called, *flags* indicates how *data* should be handled.

Parameters

in	*arg*	User-defined argument.
in	*data*	Points to the received data. This data may persist after the callback returns and needs to be freed with ucp_am_data_release.
in	*length*	Length of data.
in	*reply_ep*	If the Active Message is sent with the UCP_AM_SEND_FLAG_REPLY flag, the sending ep will be passed in. If not, NULL will be passed.
in	*flags*	If this flag is set to UCP_CB_PARAM_FLAG_DATA, the callback can return UCS_INPROGRESS and data will persist after the callback returns.

Returns

UCS_OK *data* will not persist after the callback returns.
UCS_INPROGRESS Can only be returned if flags is set to UCP_CB_PARAM_FLAG_DATA. If UCP_INPR←
OGRESS is returned, data will persist after the callback has returned. To free the memory, a pointer to the data must be passed into ucp_am_data_release.

Note

This callback should be set and released by ucp_worker_set_am_handler function.

6.6.3.8 ucp_am_recv_callback_t

```
typedef ucs_status_t(* ucp_am_recv_callback_t) (void *arg, const void *header, size_t header_←
length, void *data, size_t length, const ucp_am_recv_param_t *param)
```

The callback is always called from the progress context, therefore calling ucp_worker_progress() is not allowed. It is recommended to define callbacks with relatively short execution time to avoid blocking of communication progress.

Parameters

in	*arg*	User-defined argument.
in	*header*	User defined active message header. If *header_length* is 0, this value is undefined and must not be accessed.
in	*header_length*	Active message header length in bytes.
in	*data*	Points to the received data if *UCP_AM_RECV_ATTR_FLAG_RNDV* flag is not set in ucp_am_recv_param_t::recv_attr. Otherwise it points to the internal UCP descriptor which can further be used for initiating data receive by using ucp_am_recv_data_nbx routine.
in	*length*	Length of data. If *UCP_AM_RECV_ATTR_FLAG_RNDV* flag is set in ucp_am_recv_param_t::recv_attr, it indicates the required receive buffer size for initiating rendezvous protocol.
in	*param*	Data receive parameters.

Returns

UCS_OK *data* will not persist after the callback returns. If UCP_AM_RECV_ATTR_FLAG_RNDV flag is set in *param->recv_attr* and ucp_am_recv_data_nbx was not called for this data, the data descriptor will be dropped and the corresponding ucp_am_send_nbx call will complete with UCS_OK status.
UCS_INPROGRESS Can only be returned if *param->recv_attr* flags contains UCP_AM_RECV_ATTR_FL↩ AG_DATA or UCP_AM_RECV_ATTR_FLAG_RNDV. The *data* will persist after the callback has returned. To free the memory, a pointer to the data must be passed into ucp_am_data_release or data receive is initiated by ucp_am_recv_data_nbx.
otherwise Can only be returned if *param->recv_attr* contains UCP_AM_RECV_ATTR_FLAG_RNDV. In this case data descriptor *data* will be dropped and the corresponding ucp_am_send_nbx call on the sender side will complete with the status returned from the callback.

Note

This callback should be set and released by ucp_worker_set_am_recv_handler function.

6.6.3.9 ucp_ep_params_t

```
typedef struct ucp_ep_params ucp_ep_params_t
```

The structure defines the parameters that are used for the UCP endpoint tuning during the UCP ep creation.

6.6.4 Enumeration Type Documentation

6.6.4.1 ucp_ep_params_field

```
enum ucp_ep_params_field
```

The enumeration allows specifying which fields in ucp_ep_params_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_EP_PARAM_FIELD_REMOTE_ADDRESS	Address of remote peer
UCP_EP_PARAM_FIELD_ERR_HANDLING_MODE	Error handling mode. ucp_err_handling_mode_t
UCP_EP_PARAM_FIELD_ERR_HANDLER	Handler to process transport level errors
UCP_EP_PARAM_FIELD_USER_DATA	User data pointer
UCP_EP_PARAM_FIELD_SOCK_ADDR	Socket address field
UCP_EP_PARAM_FIELD_FLAGS	Endpoint flags Connection request field
UCP_EP_PARAM_FIELD_CONN_REQUEST	
UCP_EP_PARAM_FIELD_NAME	Endpoint name
UCP_EP_PARAM_FIELD_LOCAL_SOCK_ADDR	Local socket Address

6.6.4.2 ucp_ep_params_flags_field

```
enum ucp_ep_params_flags_field
```

The enumeration list describes the endpoint's parameters flags supported by ucp_ep_create() function.

Enumerator

UCP_EP_PARAMS_FLAGS_CLIENT_SERVER	Using a client-server connection establishment mechanism. ucs_sock_addr_t sockaddr field must be provided and contain the address of the remote peer
UCP_EP_PARAMS_FLAGS_NO_LOOPBACK	Avoid connecting the endpoint to itself when connecting the endpoint to the same worker it was created on. Affects protocols which send to a particular remote endpoint, for example stream
UCP_EP_PARAMS_FLAGS_SEND_CLIENT_ID	Send client id when connecting to remote socket address as part of the connection request payload. On the remote side value can be obtained from ucp_conn_request_h using ucp_conn_request_query

6.6.4.3 ucp_ep_close_flags_t

```
enum ucp_ep_close_flags_t
```

The enumeration is used to specify the behavior of ucp_ep_close_nbx.

Enumerator

UCP_EP_CLOSE_FLAG_FORCE	ucp_ep_close_nbx releases the endpoint without any confirmation from the peer. All outstanding requests will be completed with UCS_ERR_CANCELED error. **Note** This mode may cause transport level errors on remote side, so it requires set UCP_ERR_HANDLING_MODE_PEER for all endpoints created on both (local and remote) sides to avoid undefined behavior. If this flag is not set then ucp_ep_close_nbx schedules flushes on all outstanding operations. this flag is incompatible with UCP_OP_ATTR_FLAG_NO_IMM_CMPL, since it forces immediate completion.

6.6.4.4 ucp_ep_perf_param_field

`enum ucp_ep_perf_param_field`

The enumeration allows specifying which fields in ucp_ep_evaluate_perf_param_t are present and operation flags are used. It is used to enable backward compatibility support.

Enumerator

UCP_EP_PERF_PARAM_FIELD_MESSAGE_SIZE	Enables ucp_ep_evaluate_perf_param_t::message_size

6.6.4.5 ucp_ep_perf_attr_field

`enum ucp_ep_perf_attr_field`

The enumeration allows specifying which fields in ucp_ep_evaluate_perf_attr_t are present and operation flags are used. It is used to enable backward compatibility support.

Enumerator

UCP_EP_PERF_ATTR_FIELD_ESTIMATED_TIME	Enables ucp_ep_evaluate_perf_attr_t::estimated_time

6.6.4.6 ucp_cb_param_flags

`enum ucp_cb_param_flags`

In a callback, if flags is set to UCP_CB_PARAM_FLAG_DATA in a callback then data was allocated, so if UCS_INPROGRESS is returned from the callback, the data parameter will persist and the user has to call ucp_am_data_release when data is no longer needed.

Enumerator

UCP_CB_PARAM_FLAG_DATA	

6.6.4.7 ucp_ep_attr_field

enum ucp_ep_attr_field

The enumeration allows specifying which fields in ucp_ep_attr_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_EP_ATTR_FIELD_NAME	UCP endpoint name
UCP_EP_ATTR_FIELD_LOCAL_SOCKADDR	Sockaddr used by the endpoint
UCP_EP_ATTR_FIELD_REMOTE_SOCKADDR	Sockaddr the endpoint is connected to
UCP_EP_ATTR_FIELD_TRANSPORTS	Transport and device used by endpoint
UCP_EP_ATTR_FIELD_USER_DATA	User data associated with the endpoint

6.6.4.8 ucp_ep_close_mode

enum ucp_ep_close_mode

Deprecated Use ucp_ep_close_nbx and ucp_ep_close_flags_t instead.

The enumeration is used to specify the behavior of ucp_ep_close_nb.

Enumerator

UCP_EP_CLOSE_MODE_FORCE	ucp_ep_close_nb releases the endpoint without any confirmation from the peer. All outstanding requests will be completed with UCS_ERR_CANCELED error. **Note** This mode may cause transport level errors on remote side, so it requires set UCP_ERR_HANDLING_MODE_PEER for all endpoints created on both (local and remote) sides to avoid undefined behavior.
UCP_EP_CLOSE_MODE_FLUSH	ucp_ep_close_nb schedules flushes on all outstanding operations.

6.6.4.9 ucp_err_handling_mode_t

enum ucp_err_handling_mode_t

Specifies error handling mode for the UCP endpoint.

Enumerator

UCP_ERR_HANDLING_MODE_NONE	No guarantees about error reporting, imposes minimal overhead from a performance perspective. **Note** In this mode, any error reporting will not generate calls to ucp_ep_params_t::err_handler.
UCP_ERR_HANDLING_MODE_PEER	Guarantees that send requests are always completed (successfully or error) even in case of remote failure, disables protocols and APIs which may cause a hang or undefined behavior in case of peer failure, may affect performance and memory footprint

6.6.5 Function Documentation

6.6.5.1 ucp_ep_create()

```
ucs_status_t ucp_ep_create (
            ucp_worker_h worker,
            const ucp_ep_params_t * params,
            ucp_ep_h * ep_p )
```

This routine creates and connects an endpoint on a local worker for a destination address that identifies the remote worker. This function is non-blocking, and communications may begin immediately after it returns. If the connection process is not completed, communications may be delayed. The created endpoint is associated with one and only one worker.

Parameters

in	*worker*	Handle to the worker; the endpoint is associated with the worker.
in	*params*	User defined ucp_ep_params_t configurations for the UCP endpoint.
out	*ep_p*	A handle to the created endpoint.

Returns

Error code as defined by ucs_status_t

Note

One of the following fields has to be specified:

- ucp_ep_params_t::address
- ucp_ep_params_t::sockaddr
- ucp_ep_params_t::conn_request

By default, ucp_ep_create() will connect an endpoint to itself if the endpoint is destined to the same *worker* on which it was created, i.e. *params.address* belongs to *worker*. This behavior can be changed by passing the UCP_EP_PARAMS_FLAGS_NO_LOOPBACK flag in *params.flags*. In that case, the endpoint will be connected to the *next* endpoint created in the same way on the same *worker*.

Examples:

ucp_client_server.c, and ucp_hello_world.c.

6.6.5.2 ucp_ep_close_nbx()

```
ucs_status_ptr_t ucp_ep_close_nbx (
            ucp_ep_h ep,
            const ucp_request_param_t * param )
```

Parameters

in	*ep*	Handle to the endpoint to close.
in	*param*	Operation parameters, see ucp_request_param_t. This operation supports specific flags, which can be passed in *param* by ucp_request_param_t::flags. The exact set of flags is defined by ucp_ep_close_flags_t.

Returns

NULL - The endpoint is closed successfully.
UCS_PTR_IS_ERR(_ptr) - The closure failed and an error code indicates the transport level status. However, resources are released and the *endpoint* can no longer be used.
otherwise - The closure process is started, and can be completed at any point in time. A request handle is returned to the application in order to track progress of the endpoint closure.

6.6.5.3 ucp_ep_print_info()

```
void ucp_ep_print_info (
            ucp_ep_h ep,
            FILE * stream )
```

This routine prints information about the endpoint transport methods, their thresholds, and other useful information associated with the endpoint.

Parameters

in	*ep*	Endpoint object whose configuration to print.
in	*stream*	Output stream to print the information to.

6.6.5.4 ucp_ep_flush_nbx()

```
ucs_status_ptr_t ucp_ep_flush_nbx (
            ucp_ep_h ep,
            const ucp_request_param_t * param )
```

This routine flushes all outstanding AMO and RMA communications on the endpoint. All the AMO and RMA operations issued on the *ep* prior to this call are completed both at the origin and at the target endpoint when this call returns.

Parameters

in	*ep*	UCP endpoint.
in	*param*	Operation parameters, see ucp_request_param_t.

Returns

NULL - The flush operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The flush operation failed.
otherwise - Flush operation was scheduled and can be completed in any point in time. The request handle is returned to the application in order to track progress.

The following example demonstrates how blocking flush can be implemented using non-blocking flush:

```
ucs_status_t blocking_ep_flush(ucp_ep_h ep, ucp_worker_h worker)
{
    ucp_request_param_t param;
    void *request;

    param.op_attr_mask = 0;
    request            = ucp_ep_flush_nbx(ep, &param);
    if (request == NULL) {
        return UCS_OK;
    } else if (UCS_PTR_IS_ERR(request)) {
        return UCS_PTR_STATUS(request);
    } else {
        ucs_status_t status;
        do {
            ucp_worker_progress(worker);
            status = ucp_request_check_status(request);
        } while (status == UCS_INPROGRESS);
        ucp_request_free(request);
        return status;
    }
}
```

Examples:

ucp_hello_world.c.

6.6.5.5 ucp_ep_evaluate_perf()

```
ucs_status_t ucp_ep_evaluate_perf (
              ucp_ep_h ep,
              const ucp_ep_evaluate_perf_param_t * param,
              ucp_ep_evaluate_perf_attr_t * attr )
```

This routine fetches information about the endpoint.

Parameters

in	*ep*	Endpoint to query.
in	*param*	Filled by the user with request params.
out	*attr*	Filled with performance estimation of the given operation on the endpoint.

Returns

Error code as defined by ucs_status_t

6.6.5.6 ucp_ep_query()

```
ucs_status_t ucp_ep_query (
              ucp_ep_h ep,
              ucp_ep_attr_t * attr )
```

This routine fetches information about the endpoint.

Parameters

in	*ep*	Endpoint object to query.
out	*attr*	Filled with attributes of the endpoint.

Returns

Error code as defined by ucs_status_t

6.6.5.7 ucp_request_release()

```
void ucp_request_release (
             void * request )
```

Deprecated Replaced by ucp_request_free.

6.6.5.8 ucp_ep_destroy()

```
void ucp_ep_destroy (
             ucp_ep_h ep )
```

Deprecated Replaced by ucp_ep_close_nb.

6.6.5.9 ucp_disconnect_nb()

```
ucs_status_ptr_t ucp_disconnect_nb (
             ucp_ep_h ep )
```

Deprecated Replaced by ucp_ep_close_nb.

6.6.5.10 ucp_request_test()

```
ucs_status_t ucp_request_test (
             void * request,
             ucp_tag_recv_info_t * info )
```

Deprecated Replaced by ucp_tag_recv_request_test and ucp_request_check_status depends on use case.

Note

Please use ucp_request_check_status for cases that only need to check the completion status of an outstanding request. ucp_request_check_status can be used for any type of request. ucp_tag_recv_request_test should only be used for requests returned by ucp_tag_recv_nb (or request allocated by user for ucp_tag_recv_nbr) for which additional information (returned via the *info* pointer) is needed.

6.6.5.11 ucp_ep_flush()

```
ucs_status_t ucp_ep_flush (
            ucp_ep_h ep )
```

Deprecated Replaced by ucp_ep_flush_nb.

6.6.5.12 ucp_ep_modify_nb()

```
ucs_status_ptr_t ucp_ep_modify_nb (
            ucp_ep_h ep,
            const ucp_ep_params_t * params )
```

Deprecated Use ucp_listener_conn_handler_t instead of ucp_listener_accept_handler_t, if you have other use case please submit an issue on `https://github.com/openucx/ucx` or report to `ucx-group@elist.ornl.gov`

This routine modifies endpoint created by ucp_ep_create or ucp_listener_accept_callback_t. For example, this API can be used to setup custom parameters like ucp_ep_params_t::user_data or ucp_ep_params_t::err_handler to endpoint created by ucp_listener_accept_callback_t.

Parameters

`in`	*ep*	A handle to the endpoint.
`in`	*params*	User defined ucp_ep_params_t configurations for the UCP endpoint.

Returns

NULL - The endpoint is modified successfully.
UCS_PTR_IS_ERR(_ptr) - The reconfiguration failed and an error code indicates the status. However, the *endpoint* is not modified and can be used further.
otherwise - The reconfiguration process is started, and can be completed at any point in time. A request handle is returned to the application in order to track progress of the endpoint modification. The application is responsible for releasing the handle using the ucp_request_free routine.

Note

See the documentation of ucp_ep_params_t for details, only some of the parameters can be modified.

6.6.5.13 ucp_ep_close_nb()

```
ucs_status_ptr_t ucp_ep_close_nb (
            ucp_ep_h ep,
            unsigned mode )
```

Deprecated Use ucp_ep_close_nbx instead.

This routine releases the endpoint. The endpoint closure process depends on the selected *mode*.

Parameters

in	*ep*	Handle to the endpoint to close.
in	*mode*	One from ucp_ep_close_mode value.

Returns

UCS_OK - The endpoint is closed successfully.
UCS_PTR_IS_ERR(_ptr) - The closure failed and an error code indicates the transport level status. However, resources are released and the *endpoint* can no longer be used.
otherwise - The closure process is started, and can be completed at any point in time. A request handle is returned to the application in order to track progress of the endpoint closure. The application is responsible for releasing the handle using the ucp_request_free routine.

Note

ucp_ep_close_nb replaces deprecated ucp_disconnect_nb and ucp_ep_destroy

6.6.5.14 ucp_ep_flush_nb()

```
ucs_status_ptr_t ucp_ep_flush_nb (
            ucp_ep_h ep,
            unsigned flags,
            ucp_send_callback_t cb )
```

Deprecated Use ucp_ep_flush_nbx instead.

This routine flushes all outstanding AMO and RMA communications on the endpoint. All the AMO and RMA operations issued on the *ep* prior to this call are completed both at the origin and at the target endpoint when this call returns.

Parameters

in	*ep*	UCP endpoint.
in	*flags*	Flags for flush operation. Reserved for future use.
in	*cb*	Callback which will be called when the flush operation completes.

Returns

NULL - The flush operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The flush operation failed.
otherwise - Flush operation was scheduled and can be completed in any point in time. The request handle is returned to the application in order to track progress. The application is responsible for releasing the handle using ucp_request_free() routine.

6.7 UCP Communication routines

Data Structures

- struct ucp_request_attr_t

  Attributes of a particular request. More...
- struct ucp_err_handler

  UCP endpoint error handling context. More...

Typedefs

- typedef uint64_t ucp_tag_t

  UCP Tag Identifier.
- typedef struct ucp_recv_desc ∗ ucp_tag_message_h

  UCP Message descriptor.
- typedef uint64_t ucp_datatype_t

  UCP Datatype Identifier.
- typedef void(∗ ucp_send_callback_t) (void ∗request, ucs_status_t status)

  Completion callback for non-blocking sends.
- typedef void(∗ ucp_send_nbx_callback_t) (void ∗request, ucs_status_t status, void ∗user_data)

  Completion callback for non-blocking sends.
- typedef void(∗ ucp_err_handler_cb_t) (void ∗arg, ucp_ep_h ep, ucs_status_t status)

  Callback to process peer failure.
- typedef struct ucp_err_handler ucp_err_handler_t

  UCP endpoint error handling context.
- typedef void(∗ ucp_stream_recv_callback_t) (void ∗request, ucs_status_t status, size_t length)

  Completion callback for non-blocking stream oriented receives.
- typedef void(∗ ucp_stream_recv_nbx_callback_t) (void ∗request, ucs_status_t status, size_t length, void ∗user_data)

  Completion callback for non-blocking stream receives ucp_stream_recv_nbx call.
- typedef void(∗ ucp_tag_recv_callback_t) (void ∗request, ucs_status_t status, ucp_tag_recv_info_t ∗info)

  Completion callback for non-blocking tag receives.
- typedef void(∗ ucp_tag_recv_nbx_callback_t) (void ∗request, ucs_status_t status, const ucp_tag_recv_info_t ∗tag_info, void ∗user_data)

  Completion callback for non-blocking tag receives ucp_tag_recv_nbx call.
- typedef void(∗ ucp_am_recv_data_nbx_callback_t) (void ∗request, ucs_status_t status, size_t length, void ∗user_data)

  Completion callback for non-blocking Active Message receives.

Enumerations

- enum ucp_atomic_op_t {
  UCP_ATOMIC_OP_ADD, UCP_ATOMIC_OP_SWAP, UCP_ATOMIC_OP_CSWAP, UCP_ATOMIC_OP_AND,
  UCP_ATOMIC_OP_OR, UCP_ATOMIC_OP_XOR, UCP_ATOMIC_OP_LAST }

  Atomic operation requested for ucp_atomic_op_nbx.
- enum ucp_stream_recv_flags_t { UCP_STREAM_RECV_FLAG_WAITALL = UCS_BIT(0) }

  Flags to define behavior of ucp_stream_recv_nb function.

- enum ucp_op_attr_t {
UCP_OP_ATTR_FIELD_REQUEST = UCS_BIT(0), UCP_OP_ATTR_FIELD_CALLBACK = UCS_BIT(1), UCP_OP_ATTR_FIELD_USER_DATA = UCS_BIT(2), UCP_OP_ATTR_FIELD_DATATYPE = UCS_BIT(3), UCP_OP_ATTR_FIELD_FLAGS = UCS_BIT(4), UCP_OP_ATTR_FIELD_REPLY_BUFFER = UCS_BIT(5), UCP_OP_ATTR_FIELD_MEMORY_TYPE = UCS_BIT(6), UCP_OP_ATTR_FIELD_RECV_INFO = UCS_↩
BIT(7),
UCP_OP_ATTR_FIELD_MEMH = UCS_BIT(8), UCP_OP_ATTR_FLAG_NO_IMM_CMPL = UCS_BIT(16), UCP_OP_ATTR_FLAG_FAST_CMPL = UCS_BIT(17), UCP_OP_ATTR_FLAG_FORCE_IMM_CMPL = U↩
CS_BIT(18),
UCP_OP_ATTR_FLAG_MULTI_SEND = UCS_BIT(19) }

  UCP operation fields and flags.
- enum ucp_req_attr_field { UCP_REQUEST_ATTR_FIELD_INFO_STRING = UCS_BIT(0), UCP_REQUEST_ATTR_FIELD_INF
= UCS_BIT(1), UCP_REQUEST_ATTR_FIELD_STATUS = UCS_BIT(2), UCP_REQUEST_ATTR_FIELD_MEM_TYPE
= UCS_BIT(3) }

  UCP request query attributes.
- enum ucp_am_recv_attr_t { UCP_AM_RECV_ATTR_FIELD_REPLY_EP = UCS_BIT(0), UCP_AM_RECV_ATTR_FLAG_DATA
= UCS_BIT(16), UCP_AM_RECV_ATTR_FLAG_RNDV = UCS_BIT(17) }

  UCP AM receive data parameter fields and flags.
- enum ucp_am_handler_param_field { UCP_AM_HANDLER_PARAM_FIELD_ID = UCS_BIT(0), UCP_AM_HANDLER_PARAM
= UCS_BIT(1), UCP_AM_HANDLER_PARAM_FIELD_CB = UCS_BIT(2), UCP_AM_HANDLER_PARAM_FIELD_ARG
= UCS_BIT(3) }

  UCP AM receive data parameters fields and flags.
- enum ucp_atomic_post_op_t {
UCP_ATOMIC_POST_OP_ADD, UCP_ATOMIC_POST_OP_AND, UCP_ATOMIC_POST_OP_OR, UCP_ATOMIC_POST_OP_XOR,
UCP_ATOMIC_POST_OP_LAST }

  Atomic operation requested for ucp_atomic_post.
- enum ucp_atomic_fetch_op_t {
UCP_ATOMIC_FETCH_OP_FADD, UCP_ATOMIC_FETCH_OP_SWAP, UCP_ATOMIC_FETCH_OP_CSWAP, UCP_ATOMIC_FETCH_OP_FAND,
UCP_ATOMIC_FETCH_OP_FOR, UCP_ATOMIC_FETCH_OP_FXOR, UCP_ATOMIC_FETCH_OP_LAST
}

  Atomic operation requested for ucp_atomic_fetch.

Functions

- ucs_status_t ucp_request_query (void ∗request, ucp_request_attr_t ∗attr)

  Get information about ucp_request.
- ucs_status_ptr_t ucp_am_send_nbx (ucp_ep_h ep, unsigned id, const void ∗header, size_t header_length, const void ∗buffer, size_t count, const ucp_request_param_t ∗param)

  Send Active Message.
- ucs_status_ptr_t ucp_am_recv_data_nbx (ucp_worker_h worker, void ∗data_desc, void ∗buffer, size_t count, const ucp_request_param_t ∗param)

  Receive Active Message as defined by provided data descriptor.
- void ucp_am_data_release (ucp_worker_h worker, void ∗data)

  Releases Active Message data.
- ucs_status_ptr_t ucp_stream_send_nbx (ucp_ep_h ep, const void ∗buffer, size_t count, const ucp_request_param_t ∗param)

  Non-blocking stream send operation.
- ucs_status_ptr_t ucp_tag_send_nbx (ucp_ep_h ep, const void ∗buffer, size_t count, ucp_tag_t tag, const ucp_request_param_t ∗param)

  Non-blocking tagged-send operation.
- ucs_status_ptr_t ucp_tag_send_sync_nbx (ucp_ep_h ep, const void ∗buffer, size_t count, ucp_tag_t tag, const ucp_request_param_t ∗param)

Non-blocking synchronous tagged-send operation.

- ucs_status_ptr_t ucp_stream_recv_nbx (ucp_ep_h ep, void ∗buffer, size_t count, size_t ∗length, const ucp_request_param_t ∗param)

  Non-blocking stream receive operation of structured data into a user-supplied buffer.
- ucs_status_ptr_t ucp_stream_recv_data_nb (ucp_ep_h ep, size_t ∗length)

  Non-blocking stream receive operation of unstructured data into a UCP-supplied buffer.
- ucs_status_ptr_t ucp_tag_recv_nbx (ucp_worker_h worker, void ∗buffer, size_t count, ucp_tag_t tag, ucp_tag_t tag_mask, const ucp_request_param_t ∗param)

  Non-blocking tagged-receive operation.
- ucp_tag_message_h ucp_tag_probe_nb (ucp_worker_h worker, ucp_tag_t tag, ucp_tag_t tag_mask, int remove, ucp_tag_recv_info_t ∗info)

  Non-blocking probe and return a message.
- ucs_status_ptr_t ucp_tag_msg_recv_nbx (ucp_worker_h worker, void ∗buffer, size_t count, ucp_tag_message_h message, const ucp_request_param_t ∗param)

  Non-blocking receive operation for a probed message.
- ucs_status_ptr_t ucp_put_nbx (ucp_ep_h ep, const void ∗buffer, size_t count, uint64_t remote_addr, ucp_rkey_h rkey, const ucp_request_param_t ∗param)

  Non-blocking remote memory put operation.
- ucs_status_ptr_t ucp_get_nbx (ucp_ep_h ep, void ∗buffer, size_t count, uint64_t remote_addr, ucp_rkey_h rkey, const ucp_request_param_t ∗param)

  Non-blocking remote memory get operation.
- ucs_status_ptr_t ucp_atomic_op_nbx (ucp_ep_h ep, ucp_atomic_op_t opcode, const void ∗buffer, size_↩
t count, uint64_t remote_addr, ucp_rkey_h rkey, const ucp_request_param_t ∗param)

  Post an atomic memory operation.
- ucs_status_t ucp_request_check_status (void ∗request)

  Check the status of non-blocking request.
- ucs_status_t ucp_tag_recv_request_test (void ∗request, ucp_tag_recv_info_t ∗info)

  Check the status and currently available state of non-blocking request returned from ucp_tag_recv_nb routine.
- ucs_status_t ucp_stream_recv_request_test (void ∗request, size_t ∗length_p)

  Check the status and currently available state of non-blocking request returned from ucp_stream_recv_nb routine.
- void ucp_request_cancel (ucp_worker_h worker, void ∗request)

  Cancel an outstanding communications request.
- void ucp_stream_data_release (ucp_ep_h ep, void ∗data)

  Release UCP data buffer returned by ucp_stream_recv_data_nb.
- void ucp_request_free (void ∗request)

  Release a communications request.
- void ∗ ucp_request_alloc (ucp_worker_h worker)

  Create an empty communications request.
- int ucp_request_is_completed (void ∗request)
- ucs_status_t ucp_put (ucp_ep_h ep, const void ∗buffer, size_t length, uint64_t remote_addr, ucp_rkey_h rkey)

  Blocking remote memory put operation.
- ucs_status_t ucp_get (ucp_ep_h ep, void ∗buffer, size_t length, uint64_t remote_addr, ucp_rkey_h rkey)

  Blocking remote memory get operation.
- ucs_status_t ucp_atomic_add32 (ucp_ep_h ep, uint32_t add, uint64_t remote_addr, ucp_rkey_h rkey)

  Blocking atomic add operation for 32 bit integers.
- ucs_status_t ucp_atomic_add64 (ucp_ep_h ep, uint64_t add, uint64_t remote_addr, ucp_rkey_h rkey)

  Blocking atomic add operation for 64 bit integers.
- ucs_status_t ucp_atomic_fadd32 (ucp_ep_h ep, uint32_t add, uint64_t remote_addr, ucp_rkey_h rkey, uint32_t ∗result)

  Blocking atomic fetch and add operation for 32 bit integers.
- ucs_status_t ucp_atomic_fadd64 (ucp_ep_h ep, uint64_t add, uint64_t remote_addr, ucp_rkey_h rkey, uint64_t ∗result)

Blocking atomic fetch and add operation for 64 bit integers.

- ucs_status_t ucp_atomic_swap32 (ucp_ep_h ep, uint32_t swap, uint64_t remote_addr, ucp_rkey_h rkey, uint32_t ∗result)

  Blocking atomic swap operation for 32 bit values.
- ucs_status_t ucp_atomic_swap64 (ucp_ep_h ep, uint64_t swap, uint64_t remote_addr, ucp_rkey_h rkey, uint64_t ∗result)

  Blocking atomic swap operation for 64 bit values.
- ucs_status_t ucp_atomic_cswap32 (ucp_ep_h ep, uint32_t compare, uint32_t swap, uint64_t remote_addr, ucp_rkey_h rkey, uint32_t ∗result)

  Blocking atomic conditional swap (cswap) operation for 32 bit values.
- ucs_status_t ucp_atomic_cswap64 (ucp_ep_h ep, uint64_t compare, uint64_t swap, uint64_t remote_addr, ucp_rkey_h rkey, uint64_t ∗result)

  Blocking atomic conditional swap (cswap) operation for 64 bit values.
- ucs_status_ptr_t ucp_am_send_nb (ucp_ep_h ep, uint16_t id, const void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_send_callback_t cb, unsigned flags)

  Send Active Message.
- ucs_status_ptr_t ucp_stream_send_nb (ucp_ep_h ep, const void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_send_callback_t cb, unsigned flags)

  Non-blocking stream send operation.
- ucs_status_ptr_t ucp_stream_recv_nb (ucp_ep_h ep, void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_stream_recv_callback_t cb, size_t ∗length, unsigned flags)

  Non-blocking stream receive operation of structured data into a user-supplied buffer.
- ucs_status_ptr_t ucp_tag_send_nb (ucp_ep_h ep, const void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_tag_t tag, ucp_send_callback_t cb)

  Non-blocking tagged-send operations.
- ucs_status_t ucp_tag_send_nbr (ucp_ep_h ep, const void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_tag_t tag, void ∗req)

  Non-blocking tagged-send operations with user provided request.
- ucs_status_ptr_t ucp_tag_send_sync_nb (ucp_ep_h ep, const void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_tag_t tag, ucp_send_callback_t cb)

  Non-blocking synchronous tagged-send operation.
- ucs_status_ptr_t ucp_tag_recv_nb (ucp_worker_h worker, void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_tag_t tag, ucp_tag_t tag_mask, ucp_tag_recv_callback_t cb)

  Non-blocking tagged-receive operation.
- ucs_status_t ucp_tag_recv_nbr (ucp_worker_h worker, void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_tag_t tag, ucp_tag_t tag_mask, void ∗req)

  Non-blocking tagged-receive operation.
- ucs_status_ptr_t ucp_tag_msg_recv_nb (ucp_worker_h worker, void ∗buffer, size_t count, ucp_datatype_t datatype, ucp_tag_message_h message, ucp_tag_recv_callback_t cb)

  Non-blocking receive operation for a probed message.
- ucs_status_t ucp_put_nbi (ucp_ep_h ep, const void ∗buffer, size_t length, uint64_t remote_addr, ucp_rkey_h rkey)

  Non-blocking implicit remote memory put operation.
- ucs_status_ptr_t ucp_put_nb (ucp_ep_h ep, const void ∗buffer, size_t length, uint64_t remote_addr, ucp_rkey_h rkey, ucp_send_callback_t cb)

  Non-blocking remote memory put operation.
- ucs_status_t ucp_get_nbi (ucp_ep_h ep, void ∗buffer, size_t length, uint64_t remote_addr, ucp_rkey_h rkey)

  Non-blocking implicit remote memory get operation.
- ucs_status_ptr_t ucp_get_nb (ucp_ep_h ep, void ∗buffer, size_t length, uint64_t remote_addr, ucp_rkey_h rkey, ucp_send_callback_t cb)

  Non-blocking remote memory get operation.
- ucs_status_t ucp_atomic_post (ucp_ep_h ep, ucp_atomic_post_op_t opcode, uint64_t value, size_t op_size, uint64_t remote_addr, ucp_rkey_h rkey)

Post an atomic memory operation.

- ucs_status_ptr_t ucp_atomic_fetch_nb (ucp_ep_h ep, ucp_atomic_fetch_op_t opcode, uint64_t value, void ∗result, size_t op_size, uint64_t remote_addr, ucp_rkey_h rkey, ucp_send_callback_t cb)

  Post an atomic fetch operation.

6.7.1 Detailed Description

UCP Communication routines

6.7.2 Data Structure Documentation

6.7.2.1 struct ucp_request_attr_t

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_req_attr_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
char ∗	debug_string	Pointer to allocated string of size debug_string_size that will be filled with debug information about transports and protocols that were selected to complete the request.
size_t	debug_string_size	Size of the debug_string. String will be filled up to this size. Maximum possible size debug string can be obtained by querying the worker via ucp_worker_query.
ucs_status_t	status	Status of the request. The same as ucp_request_check_status.
ucs_memory_type_t	mem_type	Detected memory type of the buffer passed to the operation.

6.7.2.2 struct ucp_err_handler

This structure should be initialized in ucp_ep_params_t to handle peer failure

Data Fields

ucp_err_handler_cb_t	cb	Error handler callback, if NULL, will not be called.
void ∗	arg	User defined argument associated with an endpoint, it will be overridden by ucp_ep_params_t::user_data if both are set.

6.7.3 Typedef Documentation

6.7.3.1 ucp_tag_t

```
typedef uint64_t ucp_tag_t
```

UCP tag identifier is a 64bit object used for message identification. UCP tag send and receive operations use the object for an implementation tag matching semantics (derivative of MPI tag matching semantics).

6.7.3.2 ucp_tag_message_h

```
typedef struct ucp_recv_desc* ucp_tag_message_h
```

UCP Message descriptor is an opaque handle for a message returned by ucp_tag_probe_nb. This handle can be passed to ucp_tag_msg_recv_nb in order to receive the message data to a specific buffer.

6.7.3.3 ucp_datatype_t

```
typedef uint64_t ucp_datatype_t
```

UCP datatype identifier is a 64bit object used for datatype identification. Predefined UCP identifiers are defined by ucp_dt_type.

6.7.3.4 ucp_send_callback_t

```
typedef void(* ucp_send_callback_t) (void *request, ucs_status_t status)
```

This callback routine is invoked whenever the send operation is completed. It is important to note that the call-back is only invoked in a case when the operation cannot be completed in place.

Parameters

in	*request*	The completed send request.
in	*status*	Completion status. If the send operation was completed successfully UCS_OK is returned. If send operation was canceled UCS_ERR_CANCELED is returned. Otherwise, an error status is returned.

6.7.3.5 ucp_send_nbx_callback_t

```
typedef void(* ucp_send_nbx_callback_t) (void *request, ucs_status_t status, void *user_data)
```

This callback routine is invoked whenever the ucp_tag_send_nbx, ucp_am_send_nbx, ucp_stream_send_nbx, ucp_put_nbx, ucp_get_nbx, ucp_atomic_op_nbx or any other "send operation" is completed.

Parameters

in	*request*	The completed send request.
in	*status*	Completion status. If the send operation was completed successfully UCS_OK is returned. If send operation was canceled UCS_ERR_CANCELED is returned. Otherwise, an error status is returned.
in	*user_data*	User data passed to "user_data" value, see ucp_request_param_t

Examples:

ucp_client_server.c.

6.7.3.6 ucp_err_handler_cb_t

```
typedef void(* ucp_err_handler_cb_t) (void *arg, ucp_ep_h ep, ucs_status_t status)
```

This callback routine is invoked when transport level error detected.

Parameters

in	*arg*	User argument to be passed to the callback.
in	*ep*	Endpoint to handle transport level error. Upon return from the callback, this *ep* is no longer usable and all subsequent operations on this *ep* will fail with the error code passed in *status*.
in	*status*	error status.

6.7.3.7 ucp_err_handler_t

```
typedef struct ucp_err_handler ucp_err_handler_t
```

This structure should be initialized in ucp_ep_params_t to handle peer failure

6.7.3.8 ucp_stream_recv_callback_t

```
typedef void(* ucp_stream_recv_callback_t) (void *request, ucs_status_t status, size_t length)
```

This callback routine is invoked whenever the receive operation is completed and the data is ready in the receive buffer.

Parameters

in	*request*	The completed receive request.
in	*status*	Completion status. If the send operation was completed successfully UCS_OK is returned. Otherwise, an error status is returned.
in	*length*	The size of the received data in bytes, always boundary of base datatype size. The value is valid only if the status is UCS_OK.

6.7.3.9 ucp_stream_recv_nbx_callback_t

```
typedef void(* ucp_stream_recv_nbx_callback_t) (void *request, ucs_status_t status, size_↩
t length, void *user_data)
```

This callback routine is invoked whenever the receive operation is completed and the data is ready in the receive buffer.

Parameters

in	*request*	The completed receive request.
in	*status*	Completion status. If the send operation was completed successfully UCS_OK is returned. Otherwise, an error status is returned.
in	*length*	The size of the received data in bytes, always on the boundary of base datatype size. The value is valid only if the status is UCS_OK.
in	*user_data*	User data passed to "user_data" value, see ucp_request_param_t.

6.7.3.10 ucp_tag_recv_callback_t

```
typedef void(* ucp_tag_recv_callback_t) (void *request, ucs_status_t status, ucp_tag_recv_info_t
*info)
```

This callback routine is invoked whenever the receive operation is completed and the data is ready in the receive buffer.

Parameters

in	*request*	The completed receive request.
in	*status*	Completion status. If the send operation was completed successfully UCS_OK is returned. If send operation was canceled UCS_ERR_CANCELED is returned. If the data can not fit into the receive buffer the UCS_ERR_MESSAGE_TRUNCATED error code is returned. Otherwise, an error status is returned.
in	*info*	Completion information The *info* descriptor is Valid only if the status is UCS_OK.

6.7.3.11 ucp_tag_recv_nbx_callback_t

```
typedef void(* ucp_tag_recv_nbx_callback_t) (void *request, ucs_status_t status, const ucp_tag_recv_info_t
*tag_info, void *user_data)
```

This callback routine is invoked whenever the receive operation is completed and the data is ready in the receive buffer.

Parameters

in	*request*	The completed receive request.
in	*status*	Completion status. If the receive operation was completed successfully UCS_OK is returned. If send operation was canceled, UCS_ERR_CANCELED is returned. If the data can not fit into the receive buffer the UCS_ERR_MESSAGE_TRUNCATED error code is returned. Otherwise, an error status is returned.
in	*tag_info*	Completion information The *info* descriptor is Valid only if the status is UCS_OK.
in	*user_data*	User data passed to "user_data" value, see ucp_request_param_t

6.7.3.12 ucp_am_recv_data_nbx_callback_t

```
typedef void(* ucp_am_recv_data_nbx_callback_t) (void *request, ucs_status_t status, size_↩
t length, void *user_data)
```

This callback routine is invoked whenever the receive operation is completed and the data is ready in the receive buffer.

Parameters

in	*request*	The completed receive request.
in	*status*	Completion status. If the receive operation was completed successfully UCS_OK is returned. Otherwise, an error status is returned.
in	*length*	The size of the received data in bytes, always boundary of base datatype size. The value is valid only if the status is UCS_OK.
in	*user_data*	User data passed to "user_data" value, see ucp_request_param_t

6.7.4 Enumeration Type Documentation

6.7.4.1 ucp_atomic_op_t

```
enum ucp_atomic_op_t
```

This enumeration defines which atomic memory operation should be performed by the ucp_atomic_op_nbx routine.

Enumerator

UCP_ATOMIC_OP_ADD	Atomic add
UCP_ATOMIC_OP_SWAP	Atomic swap
UCP_ATOMIC_OP_CSWAP	Atomic conditional swap
UCP_ATOMIC_OP_AND	Atomic and
UCP_ATOMIC_OP_OR	Atomic or
UCP_ATOMIC_OP_XOR	Atomic xor
UCP_ATOMIC_OP_LAST	

6.7.4.2 ucp_stream_recv_flags_t

```
enum ucp_stream_recv_flags_t
```

This enumeration defines behavior of ucp_stream_recv_nb function.

Enumerator

UCP_STREAM_RECV_FLAG_WAITALL	This flag requests that the operation will not be completed until all requested data is received and placed in the user buffer.

6.7.4.3 ucp_op_attr_t

```
enum ucp_op_attr_t
```

The enumeration allows specifying which fields in ucp_request_param_t are present and operation flags are used. It is used to enable backward compatibility support.

Enumerator

UCP_OP_ATTR_FIELD_REQUEST	request field
UCP_OP_ATTR_FIELD_CALLBACK	cb field
UCP_OP_ATTR_FIELD_USER_DATA	user_data field
UCP_OP_ATTR_FIELD_DATATYPE	datatype field
UCP_OP_ATTR_FIELD_FLAGS	operation-specific flags
UCP_OP_ATTR_FIELD_REPLY_BUFFER	reply_buffer field
UCP_OP_ATTR_FIELD_MEMORY_TYPE	memory type field
UCP_OP_ATTR_FIELD_RECV_INFO	recv_info field
UCP_OP_ATTR_FIELD_MEMH	memory handle field

Enumerator

UCP_OP_ATTR_FLAG_NO_IMM_CMPL	Deny immediate completion, i.e NULL cannot be returned. If a completion callback is provided, it can be called before the function returns.
UCP_OP_ATTR_FLAG_FAST_CMPL	expedite local completion, even if it delays remote data delivery. Note for implementer: this option can disable zero copy and/or rendezvous protocols which require synchronization with the remote peer before releasing the local send buffer
UCP_OP_ATTR_FLAG_FORCE_IMM_CMPL	force immediate complete operation, fail if the operation cannot be completed immediately
UCP_OP_ATTR_FLAG_MULTI_SEND	optimize for bandwidth of multiple in-flight operations, rather than for the latency of a single operation. This flag and UCP_OP_ATTR_FLAG_FAST_CMPL are mutually exclusive.

6.7.4.4 ucp_req_attr_field

`enum ucp_req_attr_field`

The enumeration allows specifying which fields in ucp_request_attr_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_REQUEST_ATTR_FIELD_INFO_STRING	
UCP_REQUEST_ATTR_FIELD_INFO_STRING_SIZE	
UCP_REQUEST_ATTR_FIELD_STATUS	
UCP_REQUEST_ATTR_FIELD_MEM_TYPE	

6.7.4.5 ucp_am_recv_attr_t

`enum ucp_am_recv_attr_t`

The enumeration allows specifying which fields in ucp_am_recv_param_t are present and receive operation flags are used. It is used to enable backward compatibility support.

Enumerator

UCP_AM_RECV_ATTR_FIELD_REPLY_EP	reply_ep field
UCP_AM_RECV_ATTR_FLAG_DATA	Indicates that the data provided in ucp_am_recv_callback_t callback can be held by the user. If UCS_INPROGRESS is returned from the callback, the data parameter will persist and the user has to call ucp_am_data_release when data is no longer needed. This flag is mutually exclusive with *UCP_AM_RECV_ATTR_FLAG_RNDV*.
UCP_AM_RECV_ATTR_FLAG_RNDV	Indicates that the arriving data was sent using rendezvous protocol. In this case *data* parameter of the ucp_am_recv_callback_t points to the internal UCP descriptor, which can be used for obtaining the actual data by calling ucp_am_recv_data_nbx routine. This flag is mutually exclusive with *UCP_AM_RECV_ATTR_FLAG_DATA*.

6.7.4.6 ucp_am_handler_param_field

enum ucp_am_handler_param_field

The enumeration allows specifying which fields in ucp_am_handler_param_t are present. It is used to enable backward compatibility support.

Enumerator

UCP_AM_HANDLER_PARAM_FIELD_ID	Indicates that ucp_am_handler_param_t::id field is valid.
UCP_AM_HANDLER_PARAM_FIELD_FLAGS	Indicates that ucp_am_handler_param_t::flags field is valid.
UCP_AM_HANDLER_PARAM_FIELD_CB	Indicates that ucp_am_handler_param_t::cb field is valid.
UCP_AM_HANDLER_PARAM_FIELD_ARG	Indicates that ucp_am_handler_param_t::arg field is valid.

6.7.4.7 ucp_atomic_post_op_t

enum ucp_atomic_post_op_t

Deprecated Use ucp_atomic_op_nbx and ucp_atomic_op_t instead.

This enumeration defines which atomic memory operation should be performed by the ucp_atomic_post family of functions. All of these are non-fetching atomics and will not result in a request handle.

Enumerator

UCP_ATOMIC_POST_OP_ADD	Atomic add
UCP_ATOMIC_POST_OP_AND	Atomic and
UCP_ATOMIC_POST_OP_OR	Atomic or
UCP_ATOMIC_POST_OP_XOR	Atomic xor
UCP_ATOMIC_POST_OP_LAST	

6.7.4.8 ucp_atomic_fetch_op_t

enum ucp_atomic_fetch_op_t

Deprecated Use ucp_atomic_op_nbx and ucp_atomic_op_t instead.

This enumeration defines which atomic memory operation should be performed by the ucp_atomic_fetch family of functions. All of these functions will fetch data from the remote node.

Enumerator

UCP_ATOMIC_FETCH_OP_FADD	Atomic Fetch and add
UCP_ATOMIC_FETCH_OP_SWAP	Atomic swap
UCP_ATOMIC_FETCH_OP_CSWAP	Atomic conditional swap
UCP_ATOMIC_FETCH_OP_FAND	Atomic Fetch and and

Enumerator

UCP_ATOMIC_FETCH_OP_FOR	Atomic Fetch and or
UCP_ATOMIC_FETCH_OP_FXOR	Atomic Fetch and xor
UCP_ATOMIC_FETCH_OP_LAST	

6.7.5 Function Documentation

6.7.5.1 ucp_request_query()

```
ucs_status_t ucp_request_query (
            void * request,
            ucp_request_attr_t * attr )
```

Parameters

in	*request*	Non-blocking request to query.
out	*attr*	Filled with attributes of the request.

Returns

Error code as defined by ucs_status_t

6.7.5.2 ucp_am_send_nbx()

```
ucs_status_ptr_t ucp_am_send_nbx (
            ucp_ep_h ep,
            unsigned id,
            const void * header,
            size_t header_length,
            const void * buffer,
            size_t count,
            const ucp_request_param_t * param )
```

This routine sends an Active Message to an ep. If the operation completes immediately, then the routine returns NULL and the callback function is ignored, even if specified. Otherwise, if no error is reported and a callback is requested (i.e. the UCP_OP_ATTR_FIELD_CALLBACK flag is set in the op_attr_mask field of *param*), then the UCP library will schedule invocation of the callback routine *param->cb.send* upon completion of the operation.

Note

If UCP_OP_ATTR_FLAG_NO_IMM_CMPL flag is set in the op_attr_mask field of *param*, then the operation will return a request handle, even if it completes immediately.
This operation supports specific flags, which can be passed in *param* by ucp_request_param_t::flags. The exact set of flags is defined by ucp_send_am_flags.

Parameters

in	*ep*	UCP endpoint where the Active Message will be run.

Parameters

in	*id*	Active Message id. Specifies which registered callback to run.
in	*header*	User defined Active Message header. NULL value is allowed if no header needed. In this case *header_length* must be set to 0. By default the header must be valid until the active message send operation completes. If the flag UCP_AM_SEND_FLAG_COPY_HEADER is specified, the header is only required to be valid until this function call returns.
in	*header_length*	Active message header length in bytes.
in	*buffer*	Pointer to the data to be sent to the target node of the Active Message.
in	*count*	Number of elements to send.
in	*param*	Operation parameters, see ucp_request_param_t.

Note

Sending only header without actual data is allowed and is recommended for transferring a latency-critical amount of data.
The maximum allowed header size can be obtained by querying worker attributes by the ucp_worker_query routine.

Returns

NULL - Active Message was sent immediately.
UCS_PTR_IS_ERR(_ptr) - Error sending Active Message.
otherwise - Operation was scheduled for send and can be completed at any point in time. The request handle is returned to the application in order to track progress of the message. If user request was not provided in *param->request*, the application is responsible for releasing the handle using ucp_request_free routine.

Examples:

ucp_client_server.c.

6.7.5.3 ucp_am_recv_data_nbx()

```
ucs_status_ptr_t ucp_am_recv_data_nbx (
            ucp_worker_h worker,
            void * data_desc,
            void * buffer,
            size_t count,
            const ucp_request_param_t * param )
```

This routine receives a message that is described by the data descriptor *data_desc*, local address *buffer*, size *count* and *param* parameters on the *worker*. The routine is non-blocking and therefore returns immediately. The receive operation is considered completed when the message is delivered to the *buffer*. If the receive operation cannot be started the routine returns an error.

Note

This routine can be performed on any valid data descriptor delivered in ucp_am_recv_callback_t. Data descriptor is considered to be valid if:

- It is a rendezvous request (*UCP_AM_RECV_ATTR_FLAG_RNDV* is set in ucp_am_recv_param_t::recv_attr) or
- It is a persistent data pointer (*UCP_AM_RECV_ATTR_FLAG_DATA* is set in ucp_am_recv_param_t::recv_attr). In this case receive operation may be needed to unpack data to device memory (for example GPU device) or some specific datatype.

After this call UCP takes ownership of *data_desc* descriptor, so there is no need to release it even if the operation fails. The routine returns a request handle instead, which can be used for tracking operation progress.

Parameters

in	*worker*	Worker that is used for the receive operation.
in	*data_desc*	Data descriptor, provided in ucp_am_recv_callback_t routine.
in	*buffer*	Pointer to the buffer to receive the data.
in	*count*	Number of elements to receive into *buffer*.
in	*param*	Operation parameters, see ucp_request_param_t.

Returns

NULL - The receive operation was completed immediately. In this case, if *param->recv_info.length* is specified in the *param*, the value to which it points is updated with the size of the received message.
UCS_PTR_IS_ERR(_ptr) - The receive operation failed.
otherwise - Receive operation was scheduled and can be completed at any point in time. The request handle is returned to the application in order to track operation progress. If user request was not provided in *param->request*, the application is responsible for releasing the handle using ucp_request_free routine.

Examples:

ucp_client_server.c.

6.7.5.4 ucp_am_data_release()

```
void ucp_am_data_release (
            ucp_worker_h worker,
            void * data )
```

This routine releases data that persisted through an Active Message callback because that callback returned UC↩S_INPROGRESS.

Parameters

in	*worker*	Worker which received the Active Message.
in	*data*	Pointer to data that was passed into the Active Message callback as the data parameter.

6.7.5.5 ucp_stream_send_nbx()

```
ucs_status_ptr_t ucp_stream_send_nbx (
            ucp_ep_h ep,
            const void * buffer,
            size_t count,
            const ucp_request_param_t * param )
```

This routine sends data that is described by the local address *buffer*, size *count* object to the destination endpoint *ep*. The routine is non-blocking and therefore returns immediately, however the actual send operation may be delayed. The send operation is considered completed when it is safe to reuse the source *buffer*. If the send operation is completed immediately the routine returns UCS_OK.

Note

The user should not modify any part of the *buffer* after this operation is called, until the operation completes.

Parameters

in	*ep*	Destination endpoint handle.
in	*buffer*	Pointer to the message buffer (payload).
in	*count*	Number of elements to send.
in	*param*	Operation parameters, see ucp_request_param_t.

Returns

NULL - The send operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The send operation failed.
otherwise - Operation was scheduled for send and can be completed at any point in time. The request handle is returned to the application in order to track progress of the message.

Examples:

ucp_client_server.c.

6.7.5.6 ucp_tag_send_nbx()

```
ucs_status_ptr_t ucp_tag_send_nbx (
            ucp_ep_h ep,
            const void * buffer,
            size_t count,
            ucp_tag_t tag,
            const ucp_request_param_t * param )
```

This routine sends a messages that is described by the local address *buffer*, size *count* object to the destination endpoint *ep*. Each message is associated with a *tag* value that is used for message matching on the ucp_tag_recv_nb or receiver. The routine is non-blocking and therefore returns immediately, however the actual send operation may be delayed. The send operation is considered completed when it is safe to reuse the source *buffer*. If the send operation is completed immediately the routine returns UCS_OK and the call-back function is **not** invoked. If the operation is **not** completed immediately and no error reported then the UCP library will schedule to invoke the call-back whenever the send operation is completed. In other words, the completion of a message can be signaled by the return code or the call-back. Immediate completion signals can be fine-tuned via the ucp_request_param_t::op_attr_mask field in the ucp_request_param_t structure. The values of this field are a bit-wise OR of the ucp_op_attr_t enumeration.

Note

The user should not modify any part of the *buffer* after this operation is called, until the operation completes.

Parameters

in	*ep*	Destination endpoint handle.
in	*buffer*	Pointer to the message buffer (payload).
in	*count*	Number of elements to send
in	*tag*	Message tag.
in	*param*	Operation parameters, see ucp_request_param_t

Returns

UCS_OK - The send operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The send operation failed.
otherwise - Operation was scheduled for send and can be completed in any point in time. The request handle is returned to the application in order to track progress of the message.

Examples:

ucp_client_server.c, and ucp_hello_world.c.

6.7.5.7 ucp_tag_send_sync_nbx()

```
ucs_status_ptr_t ucp_tag_send_sync_nbx (
            ucp_ep_h ep,
            const void * buffer,
            size_t count,
            ucp_tag_t tag,
            const ucp_request_param_t * param )
```

Same as ucp_tag_send_nbx, except the request completes only after there is a remote tag match on the message (which does not always mean the remote receive has been completed). This function never completes "in-place", and always returns a request handle.

Note

The user should not modify any part of the *buffer* after this operation is called, until the operation completes.
Returns UCS_ERR_UNSUPPORTED if UCP_ERR_HANDLING_MODE_PEER is enabled. This is a temporary implementation-related constraint that will be addressed in future releases.

Parameters

in	*ep*	Destination endpoint handle.
in	*buffer*	Pointer to the message buffer (payload).
in	*count*	Number of elements to send
in	*tag*	Message tag.
in	*param*	Operation parameters, see ucp_request_param_t

Returns

UCS_OK - The send operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The send operation failed.
otherwise - Operation was scheduled for send and can be completed in any point in time. The request handle is returned to the application in order to track progress of the message.

6.7.5.8 ucp_stream_recv_nbx()

```
ucs_status_ptr_t ucp_stream_recv_nbx (
            ucp_ep_h ep,
            void * buffer,
            size_t count,
            size_t * length,
            const ucp_request_param_t * param )
```

This routine receives data that is described by the local address *buffer*, size *count* object on the endpoint *ep*. The routine is non-blocking and therefore returns immediately. The receive operation is considered complete when the message is delivered to the buffer. If the receive operation cannot be started, then the routine returns an error.

Parameters

`in`	*ep*	UCP endpoint that is used for the receive operation.
`in`	*buffer*	Pointer to the buffer that will receive the data.
`in`	*count*	Number of elements to receive into *buffer*.
`out`	*length*	Size of the received data in bytes. The value is valid only if return code is NULL.
`in`	*param*	Operation parameters, see ucp_request_param_t. This operation supports specific flags, which can be passed in *param* by ucp_request_param_t::flags. The exact set of flags is defined by ucp_stream_recv_flags_t.

Returns

NULL - The receive operation was completed immediately. In this case the value pointed by *length* is updated by the size of received data. Note *param->recv_info* is not relevant for this function.
UCS_PTR_IS_ERR(_ptr) - The receive operation failed.
otherwise - Operation was scheduled for receive. A request handle is returned to the application in order to track progress of the operation.

Note

The amount of data received, in bytes, is always an integral multiple of the *datatype* size.

Examples:

ucp_client_server.c.

6.7.5.9 ucp_stream_recv_data_nb()

```
ucs_status_ptr_t ucp_stream_recv_data_nb (
            ucp_ep_h ep,
            size_t * length )
```

This routine receives any available data from endpoint *ep*. Unlike ucp_stream_recv_nb, the returned data is unstructured and is treated as an array of bytes. If data is immediately available, UCS_STATUS_PTR(_ptr) is returned as a pointer to the data, and *length* is set to the size of the returned data buffer. The routine is non-blocking and therefore returns immediately.

Parameters

`in`	*ep*	UCP endpoint that is used for the receive operation.
`out`	*length*	Length of received data.

Returns

NULL - No received data available on the *ep*.
UCS_PTR_IS_ERR(_ptr) - the receive operation failed and UCS_PTR_STATUS(_ptr) indicates an error.
otherwise - The pointer to the data UCS_STATUS_PTR(_ptr) is returned to the application. After the data is processed, the application is responsible for releasing the data buffer by calling the ucp_stream_data_release routine.

Note

This function returns packed data (equivalent to ucp_dt_make_contig(1)).
This function returns a pointer to a UCP-supplied buffer, whereas ucp_stream_recv_nb places the data into a user-provided buffer. In some cases, receiving data directly into a UCP-supplied buffer can be more optimal, for example by processing the incoming data in-place and thus avoiding extra memory copy operations.

6.7.5.10 ucp_tag_recv_nbx()

```
ucs_status_ptr_t ucp_tag_recv_nbx (
            ucp_worker_h worker,
            void * buffer,
            size_t count,
            ucp_tag_t tag,
            ucp_tag_t tag_mask,
            const ucp_request_param_t * param )
```

This routine receives a message that is described by the local address *buffer*, size *count*, and *info* object on the *worker*. The tag value of the receive message has to match the *tag* and *tag_mask* values, where the *tag_mask* indicates what bits of the tag have to be matched. The routine is a non-blocking and therefore returns immediately. The receive operation is considered completed when the message is delivered to the *buffer*. In order to notify the application about completion of the receive operation the UCP library will invoke the call-back *cb* when the received message is in the receive buffer and ready for application access. If the receive operation cannot be started, then the routine returns an error.

Parameters

in	*worker*	UCP worker that is used for the receive operation.
in	*buffer*	Pointer to the buffer to receive the data.
in	*count*	Number of elements to receive
in	*tag*	Message tag to expect.
in	*tag_mask*	Bit mask that indicates the bits that are used for the matching of the incoming tag against the expected tag.
in	*param*	Operation parameters, see ucp_request_param_t

Returns

NULL - The receive operation was completed immediately. In this case, if *param->recv_info.tag_info* is specified in the *param*, the value to which it points is updated with the information about the received message.
UCS_PTR_IS_ERR(_ptr) - The receive operation failed.
otherwise - Operation was scheduled for receive. The request handle is returned to the application in order to track progress of the operation. The application is responsible for releasing the handle using ucp_request_free() routine.

Examples:

ucp_client_server.c.

6.7.5.11 ucp_tag_probe_nb()

```
ucp_tag_message_h ucp_tag_probe_nb (
            ucp_worker_h worker,
            ucp_tag_t tag,
            ucp_tag_t tag_mask,
            int remove,
            ucp_tag_recv_info_t * info )
```

This routine probes (checks) if a messages described by the *tag* and *tag_mask* was received (fully or partially) on the *worker*. The tag value of the received message has to match the *tag* and *tag_mask* values, where the *tag_mask* indicates what bits of the tag have to be matched. The function returns immediately and if the message is matched it returns a handle for the message.

Parameters

in	*worker*	UCP worker that is used for the probe operation.
in	*tag*	Message tag to probe for.
in	*tag_mask*	Bit mask that indicates the bits that are used for the matching of the incoming tag against the expected tag.
in	*remove*	The flag indicates if the matched message has to be removed from UCP library. If true (1), the message handle is removed from the UCP library and the application is responsible to call ucp_tag_msg_recv_nb() in order to receive the data and release the resources associated with the message handle. If false (0), the return value is merely an indication to whether a matching message is present, and it cannot be used in any other way, and in particular it cannot be passed to ucp_tag_msg_recv_nb().
out	*info*	If the matching message is found the descriptor is filled with the details about the message.

Returns

NULL - No match found.
Message handle (not NULL) - If message is matched the message handle is returned.

Note

This function does not advance the communication state of the network. If this routine is used in busy-poll mode, need to make sure ucp_worker_progress() is called periodically to extract messages from the transport.

Examples:

ucp_hello_world.c.

6.7.5.12 ucp_tag_msg_recv_nbx()

```
ucs_status_ptr_t ucp_tag_msg_recv_nbx (
            ucp_worker_h worker,
            void * buffer,
            size_t count,
            ucp_tag_message_h message,
            const ucp_request_param_t * param )
```

This routine receives a message that is described by the local address *buffer*, size *count*, and *message* handle on the *worker*. The *message* handle can be obtained by calling the ucp_tag_probe_nb() routine. The ucp_tag_msg_recv_nbx() routine is non-blocking and therefore returns immediately. The receive operation is considered completed when the message is delivered to the *buffer*. In order to notify the application about completion of the receive operation the UCP library will invoke the call-back *cb* when the received message is in the receive buffer and ready for application access. If the receive operation cannot be started, then the routine returns an error.

Parameters

in	*worker*	UCP worker that is used for the receive operation.
in	*buffer*	Pointer to the buffer that will receive the data.
in	*count*	Number of elements to receive
in	*message*	Message handle.
in	*param*	Operation parameters, see ucp_request_param_t

Returns

UCS_PTR_IS_ERR(_ptr) - The receive operation failed.
otherwise - Operation was scheduled for receive. The request handle is returned to the application in order to track progress of the operation. The application is responsible for releasing the handle using ucp_request_free() routine.

Examples:

ucp_hello_world.c.

6.7.5.13 ucp_put_nbx()

```
ucs_status_ptr_t ucp_put_nbx (
            ucp_ep_h ep,
            const void * buffer,
            size_t count,
            uint64_t remote_addr,
            ucp_rkey_h rkey,
            const ucp_request_param_t * param )
```

This routine initiates a storage of contiguous block of data that is described by the local address *buffer* in the remote contiguous memory region described by *remote_addr* address and the memory handle rkey. The routine returns immediately and **does not** guarantee re-usability of the source address *buffer*. If the operation is completed immediately the routine return UCS_OK, otherwise UCS_INPROGRESS or an error is returned to user. If the put operation completes immediately, the routine returns UCS_OK and the call-back routine *param.cb.send* is **not** invoked. If the operation is **not** completed immediately and no error is reported, then the UCP library will schedule invocation of the call-back routine *param.cb.send* upon completion of the put operation. In other words, the completion of a put operation can be signaled by the return code or execution of the call-back. Immediate completion signals can be fine-tuned via the ucp_request_param_t::op_attr_mask field in the ucp_request_param_t structure. The values of this field are a bit-wise OR of the ucp_op_attr_t enumeration.

Note

The completion of a put operation signals the local *buffer* can be reused. The completion of the operation on the remote address requires use of ucp_worker_flush_nbx() or ucp_ep_flush_nbx(), after completion of which the data in *remote_addr* is guaranteed to be available.

Parameters

in	*ep*	Remote endpoint handle.
in	*buffer*	Pointer to the local source address.
in	*count*	Number of elements of type ucp_request_param_t::datatype to put. If ucp_request_param_t::datatype is not specified, the type defaults to ucp_dt_make_contig(1), which corresponds to byte elements.
in	*remote_addr*	Pointer to the destination remote memory address to write to.
in	*rkey*	Remote memory key associated with the remote memory address.
in	*param*	Operation parameters, see ucp_request_param_t

Returns

UCS_OK - The operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The operation failed.
otherwise - Operation was scheduled and can be completed at any point in time. The request handle is returned to the application in order to track progress of the operation. The application is responsible for releasing the handle using ucp_request_free() routine.

Note

Only the datatype ucp_dt_make_contig(1) is supported for *param->datatype*, see ucp_dt_make_contig.

6.7.5.14 ucp_get_nbx()

```
ucs_status_ptr_t ucp_get_nbx (
             ucp_ep_h ep,
             void * buffer,
             size_t count,
             uint64_t remote_addr,
             ucp_rkey_h rkey,
             const ucp_request_param_t * param )
```

This routine initiates a load of a contiguous block of data that is described by the remote memory address *remote←_addr* and the memory handle *rkey* in the local contiguous memory region described by *buffer* address. The routine returns immediately and **does not** guarantee that remote data is loaded and stored under the local address *buffer*. If the operation is completed immediately the routine return UCS_OK, otherwise UCS_INPROGRESS or an error is returned to user. If the get operation completes immediately, the routine returns UCS_OK and the call-back routine *param.cb.send* is **not** invoked. If the operation is **not** completed immediately and no error is reported, then the UCP library will schedule invocation of the call-back routine *param.cb.send* upon completion of the get operation. In other words, the completion of a get operation can be signaled by the return code or execution of the call-back.

Note

A user can use ucp_worker_flush_nb() in order to guarantee re-usability of the source address *buffer*.
The completion of a get operation signals the local *buffer* holds the the expected data and that both local *buffer* and remote *remote_addr* are safe to be reused, unlike with ucp_put_nbx where the use of ucp_worker_flush_nbx() or ucp_ep_flush_nbx() is required before the remote data is available.

Parameters

in	*ep*	Remote endpoint handle.
in	*buffer*	Pointer to the local destination address.
in	*count*	Number of elements of type ucp_request_param_t::datatype to put. If ucp_request_param_t::datatype is not specified, the type defaults to ucp_dt_make_contig(1), which corresponds to byte elements.
in	*remote_addr*	Pointer to the source remote memory address to read from.
in	*rkey*	Remote memory key associated with the remote memory address.
in	*param*	Operation parameters, see ucp_request_param_t.

Returns

UCS_OK - The operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The operation failed.
otherwise - Operation was scheduled and can be completed at any point in time. The request handle is returned to the application in order to track progress of the operation. The application is responsible for releasing the handle using ucp_request_free() routine.

Note

Only the datatype ucp_dt_make_contig(1) is supported for *param->datatype*, see ucp_dt_make_contig.

6.7.5.15 ucp_atomic_op_nbx()

```
ucs_status_ptr_t ucp_atomic_op_nbx (
            ucp_ep_h ep,
            ucp_atomic_op_t opcode,
            const void * buffer,
            size_t count,
            uint64_t remote_addr,
            ucp_rkey_h rkey,
            const ucp_request_param_t * param )
```

This routine will post an atomic operation to remote memory. The remote value is described by the combination of the remote memory address *remote_addr* and the remote memory handle *rkey*. The routine is non-blocking and therefore returns immediately. However, the actual atomic operation may be delayed. In order to enable fetching semantics for atomic operations user has to specify *param.reply_buffer*. Please see 6.154 below for more details.

Note

The user should not modify any part of the *buffer* (or also *param->reply_buffer* for fetch operations), until the operation completes.
Only ucp_dt_make_config(4) and ucp_dt_make_contig(8) are supported in *param->datatype*, see ucp_dt_make_contig. Also, currently atomic operations can handle one element only. Thus, *count* argument must be set to 1.

Table 6.154: Atomic Operations Semantic

Atomic Operation	Pseudo code	X	Y	Z	Result
UCP_ATOMIC_OP_ADD	Result=Y; Y+=X	buffer	remote_addr	-	param.reply_buffer(optional)
UCP_ATOMIC_OP_SWAP	Result=Y; Y=X	buffer	remote_addr	-	param.reply_buffer
UCP_ATOMIC_OP_CSWAP	Result=Y; if (X==Y) then Y=Z	buffer	remote_addr	param.reply_buffer	param.reply_buffer
UCP_ATOMIC_OP_AND	Result=Y; Y&=X	buffer	remote_addr	-	param.reply_buffer(optional)
UCP_ATOMIC_OP_OR	Result=Y; Y|=X	buffer	remote_addr	-	param.reply_buffer(optional)
UCP_ATOMIC_OP_XOR	Result=Y; Y^=X	buffer	remote_addr	-	param.reply_buffer(optional)

Parameters

in	*ep*	UCP endpoint.
in	*opcode*	One of ucp_atomic_op_t.
in	*buffer*	Address of operand for the atomic operation. See 6.154 for exact usage by different atomic operations.
in	*count*	Number of elements in *buffer* and *result*. The size of each element is specified by ucp_request_param_t::datatype
in	*remote_addr*	Remote address to operate on.
in	*rkey*	Remote key handle for the remote memory address.
in	*param*	Operation parameters, see ucp_request_param_t.

Returns

NULL - The operation completed immediately.
UCS_PTR_IS_ERR(_ptr) - The operation failed.
otherwise - Operation was scheduled and can be completed at some time in the future. The request handle is returned to the application in order to track progress of the operation.

6.7.5.16 ucp_request_check_status()

```
ucs_status_t ucp_request_check_status (
            void * request )
```

This routine checks the state of the request and returns its current status. Any value different from UCS_INPRO↩ GRESS means that request is in a completed state.

Parameters

in	*request*	Non-blocking request to check.

Returns

Error code as defined by ucs_status_t

Examples:

ucp_client_server.c, and ucp_hello_world.c.

6.7.5.17 ucp_tag_recv_request_test()

```
ucs_status_t ucp_tag_recv_request_test (
            void * request,
            ucp_tag_recv_info_t * info )
```

This routine checks the state and returns current status of the request returned from ucp_tag_recv_nb routine or the user allocated request for ucp_tag_recv_nbr. Any value different from UCS_INPROGRESS means that the request is in a completed state.

Parameters

in	*request*	Non-blocking request to check.
out	*info*	It is filled with the details about the message available at the moment of calling.

Returns

Error code as defined by ucs_status_t

6.7.5.18 ucp_stream_recv_request_test()

```
ucs_status_t ucp_stream_recv_request_test (
            void * request,
            size_t * length_p )
```

This routine checks the state and returns current status of the request returned from ucp_stream_recv_nb routine. Any value different from UCS_INPROGRESS means that the request is in a completed state.

Parameters

in	*request*	Non-blocking request to check.
out	*length←_p*	The size of the received data in bytes. This value is only valid if the status is UCS_OK. If valid, it is always an integral multiple of the datatype size associated with the request.

Returns

Error code as defined by ucs_status_t

6.7.5.19 ucp_request_cancel()

```
void ucp_request_cancel (
            ucp_worker_h worker,
            void * request )
```

Parameters

in	*worker*	UCP worker.
in	*request*	Non-blocking request to cancel.

This routine tries to cancels an outstanding communication request. After calling this routine, the *request* will be in completed or canceled (but not both) state regardless of the status of the target endpoint associated with the communication request. If the request is completed successfully, the send or receive completion callbacks (based on the type of the request) will be called with the *status* argument of the callback set to UCS_OK, and in a case it is canceled the *status* argument is set to UCS_ERR_CANCELED. It is important to note that in order to release the request back to the library the application is responsible for calling ucp_request_free().

6.7.5.20 ucp_stream_data_release()

```
void ucp_stream_data_release (
              ucp_ep_h ep,
              void * data )
```

Parameters

in	*ep*	Endpoint *data* received from.
in	*data*	Data pointer to release, which was returned from ucp_stream_recv_data_nb.

This routine releases internal UCP data buffer returned by ucp_stream_recv_data_nb when *data* is processed, the application can't use this buffer after calling this function.

6.7.5.21 ucp_request_free()

```
void ucp_request_free (
              void * request )
```

Parameters

in	*request*	Non-blocking request to release.

This routine releases the non-blocking request back to the library, regardless of its current state. Communications operations associated with this request will make progress internally, however no further notifications or callbacks will be invoked for this request.

Examples:

ucp_client_server.c, and ucp_hello_world.c.

6.7.5.22 ucp_request_alloc()

```
void* ucp_request_alloc (
              ucp_worker_h worker )
```

Parameters

in	*worker*	UCP worker.

Returns

Error code as defined by ucs_status_t

This routine creates request which may be used in functions ucp_tag_send_nbx, ucp_tag_recv_nbx, etc. The application is responsible for releasing the handle using the ucp_request_free routine

6.7.5.23 ucp_request_is_completed()

```
int ucp_request_is_completed (
              void * request )
```

Deprecated Replaced by ucp_request_test.

6.7.5.24 ucp_put()

```
ucs_status_t ucp_put (
            ucp_ep_h ep,
            const void * buffer,
            size_t length,
            uint64_t remote_addr,
            ucp_rkey_h rkey )
```

Deprecated Replaced by ucp_put_nb. The following example implements the same functionality using ucp_put_nb :

```
void empty_callback(void *request, ucs_status_t status)
{
}

ucs_status_t put(ucp_ep_h ep, const void *buffer, size_t length,
                 uint64_t remote_addr, ucp_rkey_h rkey)
{
    void *request = ucp_put_nb(ep, buffer, length, remote_addr, rkey,
                               empty_callback),
    if (request == NULL) {
        return UCS_OK;
    } else if (UCS_PTR_IS_ERR(request)) {
        return UCS_PTR_STATUS(request);
    } else {
        ucs_status_t status;
        do {
            ucp_worker_progress(worker);
            status = ucp_request_check_status(request);
        } while (status == UCS_INPROGRESS);
        ucp_request_release(request);
        return status;
    }
}
```

This routine stores contiguous block of data that is described by the local address *buffer* in the remote contiguous memory region described by *remote_addr* address and the memory handle *rkey*. The routine returns when it is safe to reuse the source address *buffer*.

Parameters

in	*ep*	Remote endpoint handle.
in	*buffer*	Pointer to the local source address.
in	*length*	Length of the data (in bytes) stored under the source address.
in	*remote_addr*	Pointer to the destination remote address to write to.
in	*rkey*	Remote memory key associated with the remote address.

Returns

Error code as defined by ucs_status_t

6.7.5.25 ucp_get()

```
ucs_status_t ucp_get (
            ucp_ep_h ep,
            void * buffer,
            size_t length,
            uint64_t remote_addr,
            ucp_rkey_h rkey )
```

Deprecated Replaced by ucp_get_nb.

See also

ucp_put.

This routine loads contiguous block of data that is described by the remote address *remote_addr* and the memory handle *rkey* in the local contiguous memory region described by *buffer* address. The routine returns when remote data is loaded and stored under the local address *buffer*.

Parameters

in	*ep*	Remote endpoint handle.
in	*buffer*	Pointer to the local source address.
in	*length*	Length of the data (in bytes) stored under the source address.
in	*remote_addr*	Pointer to the destination remote address to write to.
in	*rkey*	Remote memory key associated with the remote address.

Returns

Error code as defined by ucs_status_t

6.7.5.26 ucp_atomic_add32()

```
ucs_status_t ucp_atomic_add32 (
              ucp_ep_h ep,
              uint32_t add,
              uint64_t remote_addr,
              ucp_rkey_h rkey )
```

Deprecated Replaced by ucp_atomic_post with opcode UCP_ATOMIC_POST_OP_ADD.

See also

ucp_put.

This routine performs an add operation on a 32 bit integer value atomically. The remote integer value is described by the combination of the remote memory address *remote_addr* and the remote memory handle *rkey*. The *add* value is the value that is used for the add operation. When the operation completes the sum of the original remote value and the operand value (*add*) is stored in remote memory. The call to the routine returns immediately, independent of operation completion.

Note

The remote address must be aligned to 32 bit.

Parameters

in	*ep*	Remote endpoint handle.
in	*add*	Value to add.
in	*remote_addr*	Pointer to the destination remote address of the atomic variable.
in	*rkey*	Remote memory key associated with the remote address.

Returns

Error code as defined by ucs_status_t

6.7.5.27 ucp_atomic_add64()

```
ucs_status_t ucp_atomic_add64 (
             ucp_ep_h ep,
             uint64_t add,
             uint64_t remote_addr,
             ucp_rkey_h rkey )
```

Deprecated Replaced by ucp_atomic_post with opcode UCP_ATOMIC_POST_OP_ADD.

See also

ucp_put.

This routine performs an add operation on a 64 bit integer value atomically. The remote integer value is described by the combination of the remote memory address *remote_addr* and the remote memory handle *rkey*. The *add* value is the value that is used for the add operation. When the operation completes the sum of the original remote value and the operand value (*add*) is stored in remote memory. The call to the routine returns immediately, independent of operation completion.

Note

The remote address must be aligned to 64 bit.

Parameters

in	*ep*	Remote endpoint handle.
in	*add*	Value to add.
in	*remote_addr*	Pointer to the destination remote address of the atomic variable.
in	*rkey*	Remote memory key associated with the remote address.

Returns

Error code as defined by ucs_status_t

6.7.5.28 ucp_atomic_fadd32()

```
ucs_status_t ucp_atomic_fadd32 (
             ucp_ep_h ep,
             uint32_t add,
             uint64_t remote_addr,
             ucp_rkey_h rkey,
             uint32_t * result )
```

Deprecated Replaced by ucp_atomic_fetch_nb with opcode UCP_ATOMIC_FETCH_OP_FADD.

See also

ucp_put.

This routine performs an add operation on a 32 bit integer value atomically. The remote integer value is described by the combination of the remote memory address *remote_addr* and the remote memory handle *rkey*. The *add* value is the value that is used for the add operation. When the operation completes, the original remote value is stored in the local memory *result*, and the sum of the original remote value and the operand value is stored in remote memory. The call to the routine returns when the operation is completed and the *result* value is updated.

Note

The remote address must be aligned to 32 bit.

Parameters

in	*ep*	Remote endpoint handle.
in	*add*	Value to add.
in	*remote_addr*	Pointer to the destination remote address of the atomic variable.
in	*rkey*	Remote memory key associated with the remote address.
out	*result*	Pointer to the address that is used to store the previous value of the atomic variable described by the *remote_addr*

Returns

Error code as defined by ucs_status_t

6.7.5.29 ucp_atomic_fadd64()

```
ucs_status_t ucp_atomic_fadd64 (
              ucp_ep_h ep,
              uint64_t add,
              uint64_t remote_addr,
              ucp_rkey_h rkey,
              uint64_t * result )
```

Deprecated Replaced by ucp_atomic_fetch_nb with opcode UCP_ATOMIC_FETCH_OP_FADD.

See also

ucp_put.

This routine performs an add operation on a 64 bit integer value atomically. The remote integer value is described by the combination of the remote memory address *remote_addr* and the remote memory handle *rkey*. The *add* value is the value that is used for the add operation. When the operation completes, the original remote value is stored in the local memory *result*, and the sum of the original remote value and the operand value is stored in remote memory. The call to the routine returns when the operation is completed and the *result* value is updated.

Note

The remote address must be aligned to 64 bit.

Parameters

in	*ep*	Remote endpoint handle.
in	*add*	Value to add.
in	*remote_addr*	Pointer to the destination remote address of the atomic variable.
in	*rkey*	Remote memory key associated with the remote address.
out	*result*	Pointer to the address that is used to store the previous value of the atomic variable described by the *remote_addr*

Returns

Error code as defined by ucs_status_t

6.7.5.30 ucp_atomic_swap32()

```
ucs_status_t ucp_atomic_swap32 (
             ucp_ep_h ep,
             uint32_t swap,
             uint64_t remote_addr,
             ucp_rkey_h rkey,
             uint32_t * result )
```

Deprecated Replaced by ucp_atomic_fetch_nb with opcode UCP_ATOMIC_FETCH_OP_SWAP.

See also

ucp_put.

This routine swaps a 32 bit value between local and remote memory. The remote value is described by the combination of the remote memory address *remote_addr* and the remote memory handle *rkey*. The *swap* value is the value that is used for the swap operation. When the operation completes, the remote value is stored in the local memory *result*, and the operand value (*swap*) is stored in remote memory. The call to the routine returns when the operation is completed and the *result* value is updated.

Note

The remote address must be aligned to 32 bit.

Parameters

in	*ep*	Remote endpoint handle.
in	*swap*	Value to swap.
in	*remote_addr*	Pointer to the destination remote address of the atomic variable.
in	*rkey*	Remote memory key associated with the remote address.
out	*result*	Pointer to the address that is used to store the previous value of the atomic variable described by the *remote_addr*

Returns

Error code as defined by ucs_status_t

6.7.5.31 ucp_atomic_swap64()

```
ucs_status_t ucp_atomic_swap64 (
            ucp_ep_h ep,
            uint64_t swap,
            uint64_t remote_addr,
            ucp_rkey_h rkey,
            uint64_t * result )
```

Deprecated Replaced by ucp_atomic_fetch_nb with opcode UCP_ATOMIC_FETCH_OP_SWAP.

See also

ucp_put.

This routine swaps a 64 bit value between local and remote memory. The remote value is described by the combination of the remote memory address *remote_addr* and the remote memory handle *rkey*. The *swap* value is the value that is used for the swap operation. When the operation completes, the remote value is stored in the local memory *result*, and the operand value (*swap*) is stored in remote memory. The call to the routine returns when the operation is completed and the *result* value is updated.

Note

The remote address must be aligned to 64 bit.

Parameters

in	*ep*	Remote endpoint handle.
in	*swap*	Value to swap.
in	*remote_addr*	Pointer to the destination remote address of the atomic variable.
in	*rkey*	Remote memory key associated with the remote address.
out	*result*	Pointer to the address that is used to store the previous value of the atomic variable described by the *remote_addr*

Returns

Error code as defined by ucs_status_t

6.7.5.32 ucp_atomic_cswap32()

```
ucs_status_t ucp_atomic_cswap32 (
            ucp_ep_h ep,
            uint32_t compare,
            uint32_t swap,
            uint64_t remote_addr,
            ucp_rkey_h rkey,
            uint32_t * result )
```

Deprecated Replaced by ucp_atomic_fetch_nb with opcode UCP_ATOMIC_FETCH_OP_CSWAP.

See also

ucp_put.

This routine conditionally swaps a 32 bit value between local and remote memory. The swap occurs only if the condition value (*continue*) is equal to the remote value, otherwise the remote memory is not modified. The remote value is described by the combination of the remote memory address `remote_addr` and the remote memory handle *rkey*. The `swap` value is the value that is used to update the remote memory if the condition is true. The call to the routine returns when the operation is completed and the *result* value is updated.

Note

The remote address must be aligned to 32 bit.

Parameters

`in`	*ep*	Remote endpoint handle.
`in`	*compare*	Value to compare to.
`in`	*swap*	Value to swap.
`in`	*remote_addr*	Pointer to the destination remote address of the atomic variable.
`in`	*rkey*	Remote memory key associated with the remote address.
`out`	*result*	Pointer to the address that is used to store the previous value of the atomic variable described by the *remote_addr*

Returns

Error code as defined by ucs_status_t

6.7.5.33 ucp_atomic_cswap64()

```
ucs_status_t ucp_atomic_cswap64 (
            ucp_ep_h ep,
            uint64_t compare,
            uint64_t swap,
            uint64_t remote_addr,
            ucp_rkey_h rkey,
            uint64_t * result )
```

Deprecated Replaced by ucp_atomic_fetch_nb with opcode UCP_ATOMIC_FETCH_OP_CSWAP.

See also

ucp_put.

This routine conditionally swaps a 64 bit value between local and remote memory. The swap occurs only if the condition value (*continue*) is equal to the remote value, otherwise the remote memory is not modified. The remote value is described by the combination of the remote memory address `remote_addr` and the remote memory handle *rkey*. The `swap` value is the value that is used to update the remote memory if the condition is true. The call to the routine returns when the operation is completed and the *result* value is updated.

Note

The remote address must be aligned to 64 bit.

Parameters

in	*ep*	Remote endpoint handle.
in	*compare*	Value to compare to.
in	*swap*	Value to swap.
in	*remote_addr*	Pointer to the destination remote address of the atomic variable.
in	*rkey*	Remote memory key associated with the remote address.
out	*result*	Pointer to the address that is used to store the previous value of the atomic variable described by the *remote_addr*

Returns

Error code as defined by ucs_status_t

6.7.5.34 ucp_am_send_nb()

```
ucs_status_ptr_t ucp_am_send_nb (
            ucp_ep_h ep,
            uint16_t id,
            const void * buffer,
            size_t count,
            ucp_datatype_t datatype,
            ucp_send_callback_t cb,
            unsigned flags )
```

Deprecated Use ucp_am_send_nbx instead.

This routine sends an Active Message to an ep. It does not support CUDA memory.

Parameters

in	*ep*	UCP endpoint where the Active Message will be run.
in	*id*	Active Message id. Specifies which registered callback to run.
in	*buffer*	Pointer to the data to be sent to the target node of the Active Message.
in	*count*	Number of elements to send.
in	*datatype*	Datatype descriptor for the elements in the buffer.
in	*cb*	Callback that is invoked upon completion of the data transfer if it is not completed immediately.
in	*flags*	Operation flags as defined by ucp_send_am_flags.

Returns

NULL Active Message was sent immediately.
UCS_PTR_IS_ERR(_ptr) Error sending Active Message.
otherwise Pointer to request, and Active Message is known to be completed after cb is run.

6.7.5.35 ucp_stream_send_nb()

```
ucs_status_ptr_t ucp_stream_send_nb (
            ucp_ep_h ep,
            const void * buffer,
            size_t count,
            ucp_datatype_t datatype,
            ucp_send_callback_t cb,
            unsigned flags )
```

Deprecated Use ucp_stream_send_nbx instead.

This routine sends data that is described by the local address *buffer*, size *count*, and *datatype* object to the destination endpoint *ep*. The routine is non-blocking and therefore returns immediately, however the actual send operation may be delayed. The send operation is considered completed when it is safe to reuse the source *buffer*. If the send operation is completed immediately the routine returns UCS_OK and the callback function *cb* is **not** invoked. If the operation is **not** completed immediately and no error reported, then the UCP library will schedule invocation of the callback *cb* upon completion of the send operation. In other words, the completion of the operation will be signaled either by the return code or by the callback.

Note

The user should not modify any part of the *buffer* after this operation is called, until the operation completes.

Parameters

in	*ep*	Destination endpoint handle.
in	*buffer*	Pointer to the message buffer (payload).
in	*count*	Number of elements to send.
in	*datatype*	Datatype descriptor for the elements in the buffer.
in	*cb*	Callback function that is invoked whenever the send operation is completed. It is important to note that the callback is only invoked in the event that the operation cannot be completed in place.
in	*flags*	Reserved for future use.

Returns

NULL - The send operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The send operation failed.
otherwise - Operation was scheduled for send and can be completed in any point in time. The request handle is returned to the application in order to track progress of the message. The application is responsible for releasing the handle using ucp_request_free routine.

6.7.5.36 ucp_stream_recv_nb()

```
ucs_status_ptr_t ucp_stream_recv_nb (
            ucp_ep_h ep,
            void * buffer,
            size_t count,
            ucp_datatype_t datatype,
            ucp_stream_recv_callback_t cb,
            size_t * length,
            unsigned flags )
```

Deprecated Use ucp_stream_recv_nbx instead.

This routine receives data that is described by the local address *buffer*, size *count*, and *datatype* object on the endpoint *ep*. The routine is non-blocking and therefore returns immediately. The receive operation is considered complete when the message is delivered to the buffer. If data is not immediately available, the operation will be scheduled for receive and a request handle will be returned. In order to notify the application about completion of a scheduled receive operation, the UCP library will invoke the call-back *cb* when data is in the receive buffer and ready for application access. If the receive operation cannot be started, the routine returns an error.

Parameters

`in`	*ep*	UCP endpoint that is used for the receive operation.
`in`	*buffer*	Pointer to the buffer to receive the data.
`in`	*count*	Number of elements to receive into *buffer*.
`in`	*datatype*	Datatype descriptor for the elements in the buffer.
`in`	*cb*	Callback function that is invoked whenever the receive operation is completed and the data is ready in the receive *buffer*. It is important to note that the call-back is only invoked in a case when the operation cannot be completed immediately.
`out`	*length*	Size of the received data in bytes. The value is valid only if return code is UCS_OK.

Note

The amount of data received, in bytes, is always an integral multiple of the *datatype* size.

Parameters

`in`	*flags*	Flags defined in ucp_stream_recv_flags_t.

Returns

NULL - The receive operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The receive operation failed.
otherwise - Operation was scheduled for receive. A request handle is returned to the application in order to track progress of the operation. The application is responsible for releasing the handle by calling the ucp_request_free routine.

6.7.5.37 ucp_tag_send_nb()

```
ucs_status_ptr_t ucp_tag_send_nb (
              ucp_ep_h ep,
              const void * buffer,
              size_t count,
              ucp_datatype_t datatype,
              ucp_tag_t tag,
              ucp_send_callback_t cb )
```

Deprecated Use ucp_tag_send_nbx instead.

This routine sends a messages that is described by the local address *buffer*, size *count*, and *datatype* object to the destination endpoint *ep*. Each message is associated with a *tag* value that is used for message matching on the receiver. The routine is non-blocking and therefore returns immediately, however the actual send operation may be delayed. The send operation is considered completed when it is safe to reuse the source *buffer*. If the send operation is completed immediately the routine return UCS_OK and the call-back function *cb* is **not** invoked. If the operation is **not** completed immediately and no error reported then the UCP library will schedule to invoke the call-back *cb* whenever the send operation will be completed. In other words, the completion of a message can be signaled by the return code or the call-back.

Note

The user should not modify any part of the *buffer* after this operation is called, until the operation completes.

Parameters

in	*ep*	Destination endpoint handle.
in	*buffer*	Pointer to the message buffer (payload).
in	*count*	Number of elements to send
in	*datatype*	Datatype descriptor for the elements in the buffer.
in	*tag*	Message tag.
in	*cb*	Callback function that is invoked whenever the send operation is completed. It is important to note that the call-back is only invoked in a case when the operation cannot be completed in place.

Returns

NULL - The send operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The send operation failed.
otherwise - Operation was scheduled for send and can be completed in any point in time. The request handle is returned to the application in order to track progress of the message. The application is responsible for releasing the handle using ucp_request_free() routine.

6.7.5.38 ucp_tag_send_nbr()

```
ucs_status_t ucp_tag_send_nbr (
             ucp_ep_h ep,
             const void * buffer,
             size_t count,
             ucp_datatype_t datatype,
             ucp_tag_t tag,
             void * req )
```

Deprecated Use ucp_tag_send_nbx with the flag UCP_OP_ATTR_FIELD_REQUEST instead.

This routine provides a convenient and efficient way to implement a blocking send pattern. It also completes requests faster than ucp_tag_send_nb() because:

- it always uses eager protocol to send data up to the rendezvous threshold.
- its rendezvous threshold is higher than the one used by the ucp_tag_send_nb(). The threshold is controlled by the **UCX_SEND_NBR_RNDV_THRESH** environment variable.
- its request handling is simpler. There is no callback and no need to allocate and free requests. In fact request can be allocated by caller on the stack.

This routine sends a messages that is described by the local address *buffer*, size *count*, and *datatype* object to the destination endpoint *ep*. Each message is associated with a *tag* value that is used for message matching on the receiver.

The routine is non-blocking and therefore returns immediately, however the actual send operation may be delayed. The send operation is considered completed when it is safe to reuse the source *buffer*. If the send operation is completed immediately the routine returns UCS_OK.

If the operation is **not** completed immediately and no error reported then the UCP library will fill a user provided *req* and return UCS_INPROGRESS status. In order to monitor completion of the operation ucp_request_check_status() should be used.

Following pseudo code implements a blocking send function:

```
MPI_send(...)
{
    char *request;
    ucs_status_t status;

    // allocate request on the stack
    // ucp_context_query() was used to get ucp_request_size
    request = alloca(ucp_request_size);

    // note: make sure that there is enough memory before the
    // request handle
    status = ucp_tag_send_nbr(ep, ..., request + ucp_request_size);
    if (status != UCS_INPROGRESS) {
        return status;
    }

    do {
        ucp_worker_progress(worker);
        status = ucp_request_check_status(request + ucp_request_size);
    } while (status == UCS_INPROGRESS);

    return status;
}
```

Note

The user should not modify any part of the *buffer* after this operation is called, until the operation completes.

Parameters

in	*ep*	Destination endpoint handle.
in	*buffer*	Pointer to the message buffer (payload).
in	*count*	Number of elements to send
in	*datatype*	Datatype descriptor for the elements in the buffer.
in	*tag*	Message tag.
in	*req*	Request handle allocated by the user. There should be at least UCP request size bytes of available space before the *req*. The size of UCP request can be obtained by ucp_context_query function.

Returns

UCS_OK - The send operation was completed immediately.
UCS_INPROGRESS - The send was not completed and is in progress. ucp_request_check_status() should be used to monitor *req* status.
Error code as defined by ucs_status_t

6.7.5.39 ucp_tag_send_sync_nb()

```
ucs_status_ptr_t ucp_tag_send_sync_nb (
             ucp_ep_h ep,
             const void * buffer,
             size_t count,
             ucp_datatype_t datatype,
             ucp_tag_t tag,
             ucp_send_callback_t cb )
```

Deprecated Use ucp_tag_send_sync_nbx instead.

Same as ucp_tag_send_nb, except the request completes only after there is a remote tag match on the message (which does not always mean the remote receive has been completed). This function never completes "in-place", and always returns a request handle.

Note

The user should not modify any part of the *buffer* after this operation is called, until the operation completes.
Returns UCS_ERR_UNSUPPORTED if UCP_ERR_HANDLING_MODE_PEER is enabled. This is a temporary implementation-related constraint that will be addressed in future releases.

Parameters

in	*ep*	Destination endpoint handle.
in	*buffer*	Pointer to the message buffer (payload).
in	*count*	Number of elements to send
in	*datatype*	Datatype descriptor for the elements in the buffer.
in	*tag*	Message tag.
in	*cb*	Callback function that is invoked whenever the send operation is completed.

Returns

UCS_PTR_IS_ERR(_ptr) - The send operation failed.
otherwise - Operation was scheduled for send and can be completed in any point in time. The request handle is returned to the application in order to track progress of the message. The application is responsible for releasing the handle using ucp_request_free() routine.

6.7.5.40 ucp_tag_recv_nb()

```
ucs_status_ptr_t ucp_tag_recv_nb (
             ucp_worker_h worker,
             void * buffer,
             size_t count,
             ucp_datatype_t datatype,
             ucp_tag_t tag,
             ucp_tag_t tag_mask,
             ucp_tag_recv_callback_t cb )
```

Deprecated Use ucp_tag_recv_nbx instead.

This routine receives a message that is described by the local address *buffer*, size *count*, and *datatype* object on the *worker*. The tag value of the receive message has to match the *tag* and *tag_mask* values, where the *tag_mask* indicates which bits of the tag have to be matched. The routine is non-blocking and therefore returns immediately. The receive operation is considered completed when the message is delivered to the *buffer*. In order to notify the application about completion of the receive operation the UCP library will invoke the call-back *cb* when the received message is in the receive buffer and ready for application access. If the receive operation cannot be stated the routine returns an error.

Note

This routine cannot return UCS_OK. It always returns a request handle or an error.

Parameters

in	*worker*	UCP worker that is used for the receive operation.
in	*buffer*	Pointer to the buffer to receive the data.
in	*count*	Number of elements to receive
in	*datatype*	Datatype descriptor for the elements in the buffer.
in	*tag*	Message tag to expect.
in	*tag_mask*	Bit mask that indicates the bits that are used for the matching of the incoming tag against the expected tag.
in	*cb*	Callback function that is invoked whenever the receive operation is completed and the data is ready in the receive *buffer*.

Returns

UCS_PTR_IS_ERR(_ptr) - The receive operation failed.
otherwise - Operation was scheduled for receive. The request handle is returned to the application in order to track progress of the operation. The application is responsible for releasing the handle using ucp_request_free() routine.

6.7.5.41 ucp_tag_recv_nbr()

```
ucs_status_t ucp_tag_recv_nbr (
            ucp_worker_h worker,
            void * buffer,
            size_t count,
            ucp_datatype_t datatype,
            ucp_tag_t tag,
            ucp_tag_t tag_mask,
            void * req )
```

Deprecated Use ucp_tag_recv_nbx with the flag UCP_OP_ATTR_FIELD_REQUEST instead.

This routine receives a message that is described by the local address *buffer*, size *count*, and *datatype* object on the *worker*. The tag value of the receive message has to match the *tag* and *tag_mask* values, where the *tag_mask* indicates which bits of the tag have to be matched. The routine is non-blocking and therefore returns immediately. The receive operation is considered completed when the message is delivered to the *buffer*. In order to monitor completion of the operation ucp_request_check_status or ucp_tag_recv_request_test should be used.

Parameters

in	*worker*	UCP worker that is used for the receive operation.
in	*buffer*	Pointer to the buffer to receive the data.
in	*count*	Number of elements to receive

Parameters

in	*datatype*	Datatype descriptor for the elements in the buffer.
in	*tag*	Message tag to expect.
in	*tag_mask*	Bit mask that indicates the bits that are used for the matching of the incoming tag against the expected tag.
in	*req*	Request handle allocated by the user. There should be at least UCP request size bytes of available space before the *req*. The size of UCP request can be obtained by ucp_context_query function.

Returns

Error code as defined by ucs_status_t

6.7.5.42 ucp_tag_msg_recv_nb()

```
ucs_status_ptr_t ucp_tag_msg_recv_nb (
            ucp_worker_h worker,
            void * buffer,
            size_t count,
            ucp_datatype_t datatype,
            ucp_tag_message_h message,
            ucp_tag_recv_callback_t cb )
```

Deprecated Use ucp_tag_recv_nbx instead.

This routine receives a message that is described by the local address *buffer*, size *count*, *message* handle, and *datatype* object on the *worker*. The *message* handle can be obtained by calling the ucp_tag_probe_nb() routine. The ucp_tag_msg_recv_nb() routine is non-blocking and therefore returns immediately. The receive operation is considered completed when the message is delivered to the *buffer*. In order to notify the application about completion of the receive operation the UCP library will invoke the call-back *cb* when the received message is in the receive buffer and ready for application access. If the receive operation cannot be started the routine returns an error.

Parameters

in	*worker*	UCP worker that is used for the receive operation.
in	*buffer*	Pointer to the buffer that will receive the data.
in	*count*	Number of elements to receive
in	*datatype*	Datatype descriptor for the elements in the buffer.
in	*message*	Message handle.
in	*cb*	Callback function that is invoked whenever the receive operation is completed and the data is ready in the receive *buffer*.

Returns

UCS_PTR_IS_ERR(_ptr) - The receive operation failed.
otherwise - Operation was scheduled for receive. The request handle is returned to the application in order to track progress of the operation. The application is responsible for releasing the handle using ucp_request_free() routine.

6.7.5.43 ucp_put_nbi()

```
ucs_status_t ucp_put_nbi (
             ucp_ep_h ep,
             const void * buffer,
             size_t length,
             uint64_t remote_addr,
             ucp_rkey_h rkey )
```

Deprecated Use ucp_put_nbx without passing the flag UCP_OP_ATTR_FIELD_CALLBACK instead. If a request pointer is returned, release it immediately by ucp_request_free.

This routine initiates a storage of contiguous block of data that is described by the local address *buffer* in the remote contiguous memory region described by *remote_addr* address and the memoryhandle" *rkey*. The routine returns immediately and **does not** guarantee re-usability of the source address *buffer*. If the operation is completed immediately the routine return UCS_OK, otherwise UCS_INPROGRESS or an error is returned to user.

Note

A user can use ucp_worker_flush_nb() in order to guarantee re-usability of the source address *buffer*.

Parameters

in	*ep*	Remote endpoint handle.
in	*buffer*	Pointer to the local source address.
in	*length*	Length of the data (in bytes) stored under the source address.
in	*remote_addr*	Pointer to the destination remote memory address to write to.
in	*rkey*	Remote memory key associated with the remote memory address.

Returns

Error code as defined by ucs_status_t

6.7.5.44 ucp_put_nb()

```
ucs_status_ptr_t ucp_put_nb (
             ucp_ep_h ep,
             const void * buffer,
             size_t length,
             uint64_t remote_addr,
             ucp_rkey_h rkey,
             ucp_send_callback_t cb )
```

Deprecated Use ucp_put_nbx instead.

This routine initiates a storage of contiguous block of data that is described by the local address *buffer* in the remote contiguous memory region described by *remote_addr* address and the memoryhandle" *rkey*. The routine returns immediately and **does not** guarantee re-usability of the source address *buffer*. If the operation is completed immediately the routine return UCS_OK, otherwise UCS_INPROGRESS or an error is returned to user. If the put operation completes immediately, the routine returns UCS_OK and the call-back routine *cb* is **not** invoked. If the operation is **not** completed immediately and no error is reported, then the UCP library will schedule invocation of the call-back routine *cb* upon completion of the put operation. In other words, the completion of a put operation can be signaled by the return code or execution of the call-back.

Note

A user can use ucp_worker_flush_nb() in order to guarantee re-usability of the source address *buffer*.

Parameters

in	*ep*	Remote endpoint handle.
in	*buffer*	Pointer to the local source address.
in	*length*	Length of the data (in bytes) stored under the source address.
in	*remote_addr*	Pointer to the destination remote memory address to write to.
in	*rkey*	Remote memory key associated with the remote memory address.
in	*cb*	Call-back function that is invoked whenever the put operation is completed and the local buffer can be modified. Does not guarantee remote completion.

Returns

NULL - The operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The operation failed.
otherwise - Operation was scheduled and can be completed at any point in time. The request handle is returned to the application in order to track progress of the operation. The application is responsible for releasing the handle using ucp_request_free() routine.

6.7.5.45 ucp_get_nbi()

```
ucs_status_t ucp_get_nbi (
             ucp_ep_h ep,
             void * buffer,
             size_t length,
             uint64_t remote_addr,
             ucp_rkey_h rkey )
```

Deprecated Use ucp_get_nbx without passing the flag UCP_OP_ATTR_FIELD_CALLBACK instead. If a request pointer is returned, release it immediately by ucp_request_free.

This routine initiate a load of contiguous block of data that is described by the remote memory address *remote_↩ addr* and the memory handle *rkey* in the local contiguous memory region described by *buffer* address. The routine returns immediately and **does not** guarantee that remote data is loaded and stored under the local address *buffer*.

Note

A user can use ucp_worker_flush_nb() in order guarantee that remote data is loaded and stored under the local address *buffer*.

Parameters

in	*ep*	Remote endpoint handle.
in	*buffer*	Pointer to the local destination address.
in	*length*	Length of the data (in bytes) stored under the destination address.
in	*remote_addr*	Pointer to the source remote memory address to read from.
in	*rkey*	Remote memory key associated with the remote memory address.

Returns

Error code as defined by ucs_status_t

6.7.5.46 ucp_get_nb()

```
ucs_status_ptr_t ucp_get_nb (
            ucp_ep_h ep,
            void * buffer,
            size_t length,
            uint64_t remote_addr,
            ucp_rkey_h rkey,
            ucp_send_callback_t cb )
```

Deprecated Use ucp_get_nbx instead.

This routine initiates a load of a contiguous block of data that is described by the remote memory address *remote*↩ *_addr* and the memory handle *rkey* in the local contiguous memory region described by *buffer* address. The routine returns immediately and **does not** guarantee that remote data is loaded and stored under the local address *buffer*. If the operation is completed immediately the routine return UCS_OK, otherwise UCS_INPROGRESS or an error is returned to user. If the get operation completes immediately, the routine returns UCS_OK and the call-back routine *cb* is **not** invoked. If the operation is **not** completed immediately and no error is reported, then the UCP library will schedule invocation of the call-back routine *cb* upon completion of the get operation. In other words, the completion of a get operation can be signaled by the return code or execution of the call-back.

Note

A user can use ucp_worker_flush_nb() in order to guarantee re-usability of the source address *buffer*.

Parameters

in	*ep*	Remote endpoint handle.
in	*buffer*	Pointer to the local destination address.
in	*length*	Length of the data (in bytes) stored under the destination address.
in	*remote_addr*	Pointer to the source remote memory address to read from.
in	*rkey*	Remote memory key associated with the remote memory address.
in	*cb*	Call-back function that is invoked whenever the get operation is completed and the data is visible to the local process.

Returns

NULL - The operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The operation failed.
otherwise - Operation was scheduled and can be completed at any point in time. The request handle is returned to the application in order to track progress of the operation. The application is responsible for releasing the handle using ucp_request_free() routine.

6.7.5.47 ucp_atomic_post()

```
ucs_status_t ucp_atomic_post (
            ucp_ep_h ep,
            ucp_atomic_post_op_t opcode,
            uint64_t value,
            size_t op_size,
            uint64_t remote_addr,
            ucp_rkey_h rkey )
```

Deprecated Use ucp_atomic_op_nbx without the flag UCP_OP_ATTR_FIELD_REPLY_BUFFER instead.

This routine posts an atomic memory operation to a remote value. The remote value is described by the combination of the remote memory address *remote_addr* and the remote memory handle *rkey*. Return from the function does not guarantee completion. A user must call ucp_ep_flush_nb or ucp_worker_flush_nb to guarantee that the remote value has been updated.

Parameters

in	*ep*	UCP endpoint.
in	*opcode*	One of ucp_atomic_post_op_t.
in	*value*	Source operand for the atomic operation.
in	*op_size*	Size of value in bytes
in	*remote_addr*	Remote address to operate on.
in	*rkey*	Remote key handle for the remote memory address.

Returns

Error code as defined by ucs_status_t

6.7.5.48 ucp_atomic_fetch_nb()

```
ucs_status_ptr_t ucp_atomic_fetch_nb (
              ucp_ep_h ep,
              ucp_atomic_fetch_op_t opcode,
              uint64_t value,
              void * result,
              size_t op_size,
              uint64_t remote_addr,
              ucp_rkey_h rkey,
              ucp_send_callback_t cb )
```

Deprecated Use ucp_atomic_op_nbx with the flag UCP_OP_ATTR_FIELD_REPLY_BUFFER instead.

This routine will post an atomic fetch operation to remote memory. The remote value is described by the combination of the remote memory address *remote_addr* and the remote memory handle *rkey*. The routine is non-blocking and therefore returns immediately. However the actual atomic operation may be delayed. The atomic operation is not considered complete until the values in remote and local memory are completed. If the atomic operation completes immediately, the routine returns UCS_OK and the call-back routine *cb* is **not** invoked. If the operation is **not** completed immediately and no error is reported, then the UCP library will schedule invocation of the call-back routine *cb* upon completion of the atomic operation. In other words, the completion of an atomic operation can be signaled by the return code or execution of the call-back.

Note

The user should not modify any part of the *result* after this operation is called, until the operation completes.

Parameters

`in`	*ep*	UCP endpoint.
`in`	*opcode*	One of ucp_atomic_fetch_op_t.
`in`	*value*	Source operand for atomic operation. In the case of CSWAP this is the conditional for the swap. For SWAP this is the value to be placed in remote memory.
`in,out`	*result*	Local memory address to store resulting fetch to. In the case of CSWAP the value in result will be swapped into the *remote_addr* if the condition is true.
`in`	*op_size*	Size of value in bytes and pointer type for result
`in`	*remote_addr*	Remote address to operate on.
`in`	*rkey*	Remote key handle for the remote memory address.
`in`	*cb*	Call-back function that is invoked whenever the send operation is completed. It is important to note that the call-back function is only invoked in a case when the operation cannot be completed in place.

Returns

NULL - The operation was completed immediately.
UCS_PTR_IS_ERR(_ptr) - The operation failed.
otherwise - Operation was scheduled and can be completed at any point in time. The request handle is returned to the application in order to track progress of the operation. The application is responsible for releasing the handle using ucp_request_free() routine.

6.8 UCP Configuration

Data Structures

- struct ucp_params

  Tuning parameters for UCP library. More...

Typedefs

- typedef struct ucp_params ucp_params_t

  Tuning parameters for UCP library.
- typedef struct ucp_config ucp_config_t

  UCP configuration descriptor.

Functions

- ucs_status_t ucp_config_read (const char ∗env_prefix, const char ∗filename, ucp_config_t ∗∗config_p)

  Read UCP configuration descriptor.
- void ucp_config_release (ucp_config_t ∗config)

  Release configuration descriptor.
- ucs_status_t ucp_config_modify (ucp_config_t ∗config, const char ∗name, const char ∗value)

  Modify context configuration.
- void ucp_config_print (const ucp_config_t ∗config, FILE ∗stream, const char ∗title, ucs_config_print_flags_t print_flags)

  Print configuration information.

6.8.1 Detailed Description

This section describes routines for configuration of the UCP network layer

6.8.2 Data Structure Documentation

6.8.2.1 struct ucp_params

The structure defines the parameters that are used for UCP library tuning during UCP library initialization.

Note

UCP library implementation uses the features parameter to optimize the library functionality that minimize memory footprint. For example, if the application does not require send/receive semantics UCP library may avoid allocation of expensive resources associated with send/receive queues.

Examples:

ucp_client_server.c, and ucp_hello_world.c.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_params_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.

Data Fields

uint64_t	features	UCP features that are used for library initialization. It is recommended for applications only to request the features that are required for an optimal functionality This field must be specified.
size_t	request_size	The size of a reserved space in a non-blocking requests. Typically applications use this space for caching own structures in order to avoid costly memory allocations, pointer dereferences, and cache misses. For example, MPI implementation can use this memory for caching MPI descriptors This field defaults to 0 if not specified.
ucp_request_init_callback_t	request_init	Pointer to a routine that is used for the request initialization. This function will be called only on the very first time a request memory is initialized, and may not be called again if a request is reused. If a request should be reset before the next reuse, it can be done before calling ucp_request_free. *NULL* can be used if no such is function required, which is also the default if this field is not specified by field_mask.
ucp_request_cleanup_callback_t	request_cleanup	Pointer to a routine that is responsible for final cleanup of the memory associated with the request. This routine may not be called every time a request is released. For some implementations, the cleanup call may be delayed and only invoked at ucp_worker_destroy. *NULL* can be used if no such function is required, which is also the default if this field is not specified by field_mask.
uint64_t	tag_sender_mask	Mask which specifies particular bits of the tag which can uniquely identify the sender (UCP endpoint) in tagged operations. This field defaults to 0 if not specified.
int	mt_workers_shared	This flag indicates if this context is shared by multiple workers from different threads. If so, this context needs thread safety support; otherwise, the context does not need to provide thread safety. For example, if the context is used by single worker, and that worker is shared by multiple threads, this context does not need thread safety; if the context is used by worker 1 and worker 2, and worker 1 is used by thread 1 and worker 2 is used by thread 2, then this context needs thread safety. Note that actual thread mode may be different from mode passed to ucp_init. To get actual thread mode use ucp_context_query.

Data Fields

size_t	estimated_num_eps	An optimization hint of how many endpoints will be created on this context. For example, when used from MPI or SHMEM libraries, this number will specify the number of ranks (or processing elements) in the job. Does not affect semantics, but only transport selection criteria and the resulting performance. The value can be also set by UCX_NUM_EPS environment variable. In such case it will override the number of endpoints set by *estimated_num_eps*
size_t	estimated_num_ppn	An optimization hint for a single node. For example, when used from MPI or OpenSHMEM libraries, this number will specify the number of Processes Per Node (PPN) in the job. Does not affect semantics, only transport selection criteria and the resulting performance. The value can be also set by the UCX_NUM_PPN environment variable, which will override the number of endpoints set by *estimated_num_ppn*
const char *	name	Tracing and analysis tools can identify the context using this name. To retrieve the context's name, use ucp_context_query, as the name you supply may be changed by UCX under some circumstances, e.g. a name conflict. This field is only assigned if you set UCP_PARAM_FIELD_NAME in the field mask. If not, then a default unique name will be created for you.

6.8.3 Typedef Documentation

6.8.3.1 ucp_params_t

```
typedef struct ucp_params ucp_params_t
```

The structure defines the parameters that are used for UCP library tuning during UCP library initialization.

Note

UCP library implementation uses the features parameter to optimize the library functionality that minimize memory footprint. For example, if the application does not require send/receive semantics UCP library may avoid allocation of expensive resources associated with send/receive queues.

6.8.3.2 ucp_config_t

```
typedef struct ucp_config ucp_config_t
```

This descriptor defines the configuration for UCP application context. The configuration is loaded from the run-time environment (using configuration files of environment variables) using ucp_config_read routine and can be printed using ucp_config_print routine. In addition, application is responsible to release the descriptor using ucp_config_release routine.

6.8.4 Function Documentation

6.8.4.1 ucp_config_read()

```
ucs_status_t ucp_config_read (
             const char * env_prefix,
             const char * filename,
             ucp_config_t ** config_p )
```

The routine fetches the information about UCP library configuration from the run-time environment. Then, the fetched descriptor is used for UCP library initialization. The Application can print out the descriptor using print routine. In addition the application is responsible for releasing the descriptor back to the UCP library.

Parameters

in	*env_prefix*	If non-NULL, the routine searches for the environment variables that start with <*env_prefix*>*_UCX_* prefix. Otherwise, the routine searches for the environment variables that start with *UCX_* prefix.
in	*filename*	If non-NULL, read configuration from the file defined by *filename*. If the file does not exist, it will be ignored and no error reported to the application.
out	*config_p*	Pointer to configuration descriptor as defined by ucp_config_t.

Returns

Error code as defined by ucs_status_t

Examples:

ucp_hello_world.c.

6.8.4.2 ucp_config_release()

```
void ucp_config_release (
             ucp_config_t * config )
```

The routine releases the configuration descriptor that was allocated through ucp_config_read() routine.

Parameters

out	*config*	Configuration descriptor as defined by ucp_config_t.

Examples:

ucp_hello_world.c.

6.8.4.3 ucp_config_modify()

```
ucs_status_t ucp_config_modify (
            ucp_config_t * config,
            const char * name,
            const char * value )
```

The routine changes one configuration setting stored in configuration descriptor.

Parameters

in	*config*	Configuration to modify.
in	*name*	Configuration variable name.
in	*value*	Value to set.

Returns

Error code.

6.8.4.4 ucp_config_print()

```
void ucp_config_print (
            const ucp_config_t * config,
            FILE * stream,
            const char * title,
            ucs_config_print_flags_t print_flags )
```

The routine prints the configuration information that is stored in configuration descriptor.

Parameters

in	*config*	Configuration descriptor to print.
in	*stream*	Output stream to print the configuration to.
in	*title*	Configuration title to print.
in	*print_flags*	Flags that control various printing options.

Examples:

ucp_hello_world.c.

6.9 UCP Data type routines

Data Structures

- struct ucp_dt_iov

  Structure for scatter-gather I/O. More...
- struct ucp_generic_dt_ops

  UCP generic data type descriptor.
- struct ucp_datatype_attr

  UCP datatype attributes. More...

Macros

- #define ucp_dt_make_contig(_elem_size) (((ucp_datatype_t)(_elem_size) << UCP_DATATYPE_SHIFT) | UCP_DATATYPE_CONTIG)

  Generate an identifier for contiguous data type.
- #define ucp_dt_make_iov() ((ucp_datatype_t)UCP_DATATYPE_IOV)

  Generate an identifier for Scatter-gather IOV data type.

Typedefs

- typedef struct ucp_dt_iov ucp_dt_iov_t

  Structure for scatter-gather I/O.
- typedef struct ucp_generic_dt_ops ucp_generic_dt_ops_t

  UCP generic data type descriptor.
- typedef struct ucp_datatype_attr ucp_datatype_attr_t

  UCP datatype attributes.

Enumerations

- enum ucp_dt_type {
  UCP_DATATYPE_CONTIG = 0, UCP_DATATYPE_STRIDED = 1, UCP_DATATYPE_IOV = 2, UCP_DATATYPE_GENERIC = 7,
  UCP_DATATYPE_SHIFT = 3, UCP_DATATYPE_CLASS_MASK = UCS_MASK(UCP_DATATYPE_SHIFT)
  }

  UCP data type classification.
- enum ucp_datatype_attr_field { UCP_DATATYPE_ATTR_FIELD_PACKED_SIZE = UCS_BIT(0), UCP_DATATYPE_ATTR_FIE
  = UCS_BIT(1), UCP_DATATYPE_ATTR_FIELD_COUNT = UCS_BIT(2) }

  UCP datatype attributes field mask.

Functions

- ucs_status_t ucp_dt_create_generic (const ucp_generic_dt_ops_t ∗ops, void ∗context, ucp_datatype_t ∗datatype_p)

  Create a generic datatype.
- void ucp_dt_destroy (ucp_datatype_t datatype)

  Destroy a datatype and release its resources.
- ucs_status_t ucp_dt_query (ucp_datatype_t datatype, ucp_datatype_attr_t ∗attr)

  Query attributes of a datatype.

Variables

- void ∗(∗ ucp_generic_dt_ops::start_pack)(void ∗context, const void ∗buffer, size_t count)

  Start a packing request.
- void ∗(∗ ucp_generic_dt_ops::start_unpack)(void ∗context, void ∗buffer, size_t count)

  Start an unpacking request.
- size_t(∗ ucp_generic_dt_ops::packed_size)(void ∗state)

  Get the total size of packed data.
- size_t(∗ ucp_generic_dt_ops::pack)(void ∗state, size_t offset, void ∗dest, size_t max_length)

  Pack data.
- ucs_status_t(∗ ucp_generic_dt_ops::unpack)(void ∗state, size_t offset, const void ∗src, size_t length)

  Unpack data.
- void(∗ ucp_generic_dt_ops::finish)(void ∗state)

  Finish packing/unpacking.

6.9.1 Detailed Description

UCP Data type routines

6.9.2 Data Structure Documentation

6.9.2.1 struct ucp_dt_iov

This structure is used to specify a list of buffers which can be used within a single data transfer function call. This list should remain valid until the data transfer request is completed.

Note

If *length* is zero, the memory pointed to by *buffer* will not be accessed. Otherwise, *buffer* must point to valid memory.

Examples:

ucp_client_server.c.

Data Fields

void ∗	buffer	Pointer to a data buffer
size_t	length	Length of the *buffer* in bytes

6.9.2.2 struct ucp_datatype_attr

This structure provides attributes of a UCP datatype.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from ucp_datatype_attr_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
size_t	packed_size	Packed size of the given datatype. (output parameter)

Data Fields

const void ∗	buffer	Pointer to a data buffer of the associated data type. This field is optional. If UCP_DATATYPE_ATTR_FIELD_BUFFER is not set in field_mask, this field defaults to *NULL*.
size_t	count	Number of elements in *buffer*. This value is optional. If UCP_DATATYPE_ATTR_FIELD_COUNT is not set in field_mask, the value of this field defaults to 1.

6.9.3 Macro Definition Documentation

6.9.3.1 ucp_dt_make_contig

```
#define ucp_dt_make_contig(
              _elem_size ) (((ucp_datatype_t)(_elem_size) << UCP_DATATYPE_SHIFT) | UCP_DATATYPE_CONTIG)
```

This macro creates an identifier for contiguous datatype that is defined by the size of the basic element.

Parameters

in	*_elem_size*	Size of the basic element of the type.

Returns

Data-type identifier.

Note

In case of partial receive, the buffer will be filled with integral count of elements.

Examples:

ucp_client_server.c, and ucp_hello_world.c.

6.9.3.2 ucp_dt_make_iov

```
#define ucp_dt_make_iov( ) ((ucp_datatype_t)UCP_DATATYPE_IOV)
```

This macro creates an identifier for datatype of scatter-gather list with multiple pointers

Returns

Data-type identifier.

Note

In the event of partial receive, ucp_dt_iov_t::buffer can be filled with any number of bytes according to its ucp_dt_iov_t::length.

6.9.4 Typedef Documentation

6.9.4.1 ucp_dt_iov_t

```
typedef struct ucp_dt_iov ucp_dt_iov_t
```

This structure is used to specify a list of buffers which can be used within a single data transfer function call. This list should remain valid until the data transfer request is completed.

Note

If *length* is zero, the memory pointed to by *buffer* will not be accessed. Otherwise, *buffer* must point to valid memory.

6.9.4.2 ucp_generic_dt_ops_t

```
typedef struct ucp_generic_dt_ops ucp_generic_dt_ops_t
```

This structure provides a generic datatype descriptor that is used for definition of application defined datatypes.

Typically, the descriptor is used for an integration with datatype engines implemented within MPI and SHMEM implementations.

Note

In case of partial receive, any amount of received data is acceptable which matches buffer size.

6.9.4.3 ucp_datatype_attr_t

```
typedef struct ucp_datatype_attr ucp_datatype_attr_t
```

This structure provides attributes of a UCP datatype.

6.9.5 Enumeration Type Documentation

6.9.5.1 ucp_dt_type

```
enum ucp_dt_type
```

The enumeration list describes the datatypes supported by UCP.

Enumerator

UCP_DATATYPE_CONTIG	Contiguous datatype
UCP_DATATYPE_STRIDED	Strided datatype
UCP_DATATYPE_IOV	Scatter-gather list with multiple pointers
UCP_DATATYPE_GENERIC	Generic datatype with user-defined pack/unpack routines
UCP_DATATYPE_SHIFT	Number of bits defining the datatype classification
UCP_DATATYPE_CLASS_MASK	Data-type class mask

6.9.5.2 ucp_datatype_attr_field

```
enum ucp_datatype_attr_field
```

The enumeration allows specifying which fields in ucp_datatype_attr_t are present and which datatype attributes are queried.

Enumerator

UCP_DATATYPE_ATTR_FIELD_PACKED_SIZE	ucp_datatype_attr_t::packed_size field is queried.
UCP_DATATYPE_ATTR_FIELD_BUFFER	ucp_datatype_attr_t::buffer field is set.
UCP_DATATYPE_ATTR_FIELD_COUNT	ucp_datatype_attr_t::count field is set.

6.9.6 Function Documentation

6.9.6.1 ucp_dt_create_generic()

```
ucs_status_t ucp_dt_create_generic (
            const ucp_generic_dt_ops_t * ops,
            void * context,
            ucp_datatype_t * datatype_p )
```

This routine create a generic datatype object. The generic datatype is described by the *ops* object which provides a table of routines defining the operations for generic datatype manipulation. Typically, generic datatypes are used for integration with datatype engines provided with MPI implementations (MPICH, Open MPI, etc). The application is responsible for releasing the *datatype_p* object using ucp_dt_destroy() routine.

Parameters

in	*ops*	Generic datatype function table as defined by ucp_generic_dt_ops_t .
in	*context*	Application defined context passed to this routine. The context is passed as a parameter to the routines in the *ops* table.
out	*datatype↩_p*	A pointer to datatype object.

Returns

Error code as defined by ucs_status_t

6.9.6.2 ucp_dt_destroy()

```
void ucp_dt_destroy (
            ucp_datatype_t datatype )
```

This routine destroys the *datatype* object and releases any resources that are associated with the object. The *datatype* object must be allocated using ucp_dt_create_generic() routine.

Warning

- Once the *datatype* object is released an access to this object may cause an undefined failure.

Parameters

in	*datatype*	Datatype object to destroy.

6.9.6.3 ucp_dt_query()

```
ucs_status_t ucp_dt_query (
            ucp_datatype_t datatype,
            ucp_datatype_attr_t * attr )
```

This routine fetches information about the attributes of a datatype. When UCP_DATATYPE_ATTR_FIELD_PACKED_SIZE is set in *field_mask* of *attr*, the field *packed_size* is set to the packed size (bytes) of the datatype.

Parameters

in	*datatype*	Datatype object to query.
in,out	*attr*	Filled with attributes of the datatype.

Returns

Error code as defined by ucs_status_t

6.9.7 Variable Documentation

6.9.7.1 start_pack

```
void*(* ucp_generic_dt_ops::start_pack) (void *context, const void *buffer, size_t count)
```

The pointer refers to application defined start-to-pack routine. It will be called from the ucp_tag_send_nb routine.

Parameters

in	*context*	User-defined context.
in	*buffer*	Buffer to pack.
in	*count*	Number of elements to pack into the buffer.

Returns

A custom state that is passed to the following pack() routine.

6.9.7.2 start_unpack

```
void*(* ucp_generic_dt_ops::start_unpack) (void *context, void *buffer, size_t count)
```

The pointer refers to application defined start-to-unpack routine. It will be called from the ucp_tag_recv_nb routine.

Parameters

in	*context*	User-defined context.
in	*buffer*	Buffer to unpack to.
in	*count*	Number of elements to unpack in the buffer.

Returns

A custom state that is passed later to the following unpack() routine.

6.9.7.3 packed_size

```
size_t(* ucp_generic_dt_ops::packed_size) (void *state)
```

The pointer refers to user defined routine that returns the size of data in a packed format.

Parameters

in	*state*	State as returned by start_pack() routine.

Returns

The size of the data in a packed form.

6.9.7.4 pack

```
size_t(* ucp_generic_dt_ops::pack) (void *state, size_t offset, void *dest, size_t max_length)
```

The pointer refers to application defined pack routine.

Parameters

in	*state*	State as returned by start_pack() routine.
in	*offset*	Virtual offset in the output stream.
in	*dest*	Destination buffer to pack the data.
in	*max_length*	Maximum length to pack.

Returns

The size of the data that was written to the destination buffer. Must be less than or equal to *max_length*.

6.9.7.5 unpack

```
ucs_status_t(* ucp_generic_dt_ops::unpack) (void *state, size_t offset, const void *src, size↩
_t length)
```

The pointer refers to application defined unpack routine.

Parameters

in	*state*	State as returned by start_unpack() routine.
in	*offset*	Virtual offset in the input stream.
in	*src*	Source to unpack the data from.
in	*length*	Length to unpack.

Returns

UCS_OK or an error if unpacking failed.

6.9.7.6 finish

```
void(* ucp_generic_dt_ops::finish) (void *state)
```

The pointer refers to application defined finish routine.

Parameters

in	*state*	State as returned by start_pack() and start_unpack() routines.

6.10 Unified Communication Transport (UCT) API

Modules

- UCT Communication Resource
- UCT Communication Context
- UCT Memory Domain
- UCT Active messages
- UCT Remote memory access operations
- UCT Atomic operations
- UCT Tag matching operations
- UCT client-server operations

6.10.1 Detailed Description

This section describes UCT API.

6.11 UCT Communication Resource

Modules

- UCT interface operations and capabilities

  List of capabilities supported by UCX API.
- UCT interface for asynchronous event capabilities

  List of capabilities supported by UCT iface event API.

Data Structures

- struct uct_md_resource_desc

  Memory domain resource descriptor. More...
- struct uct_component_attr

  UCT component attributes. More...
- struct uct_tl_resource_desc

  Communication resource descriptor. More...
- struct uct_iface_attr

  Interface attributes: capabilities and limitations. More...
- struct uct_iface_attr.cap
- struct uct_iface_attr.cap.put
- struct uct_iface_attr.cap.get
- struct uct_iface_attr.cap.am
- struct uct_iface_attr.cap.tag
- struct uct_iface_attr.cap.tag.recv
- struct uct_iface_attr.cap.tag.eager
- struct uct_iface_attr.cap.tag.rndv
- struct uct_iface_attr.cap.atomic32
- struct uct_iface_attr.cap.atomic64
- struct uct_iface_params

  Parameters used for interface creation. More...
- union uct_iface_params.mode
- struct uct_iface_params.mode.device
- struct uct_iface_params.mode.sockaddr
- struct uct_ep_params

  Parameters for creating a UCT endpoint by uct_ep_create. More...
- struct uct_completion

  Completion handle. More...
- struct uct_pending_req

  Pending request. More...
- struct uct_iov

  Structure for scatter-gather I/O. More...

Typedefs

- typedef struct uct_md_resource_desc uct_md_resource_desc_t

  Memory domain resource descriptor.
- typedef struct uct_component_attr uct_component_attr_t

  UCT component attributes.
- typedef struct uct_tl_resource_desc uct_tl_resource_desc_t

  Communication resource descriptor.

- typedef struct uct_component ∗ uct_component_h
- typedef struct uct_iface ∗ uct_iface_h
- typedef struct uct_iface_config uct_iface_config_t
- typedef struct uct_md_config uct_md_config_t
- typedef struct uct_cm_config uct_cm_config_t
- typedef struct uct_ep ∗ uct_ep_h
- typedef void ∗ uct_mem_h
- typedef uintptr_t uct_rkey_t
- typedef struct uct_md ∗ uct_md_h

  Memory domain handler.
- typedef struct uct_md_ops uct_md_ops_t
- typedef void ∗ uct_rkey_ctx_h
- typedef struct uct_iface_attr uct_iface_attr_t
- typedef struct uct_iface_params uct_iface_params_t
- typedef struct uct_ep_attr uct_ep_attr_t
- typedef struct uct_md_attr uct_md_attr_t
- typedef struct uct_completion uct_completion_t
- typedef struct uct_pending_req uct_pending_req_t
- typedef struct uct_worker ∗ uct_worker_h
- typedef struct uct_md uct_md_t
- typedef enum uct_am_trace_type uct_am_trace_type_t
- typedef struct uct_device_addr uct_device_addr_t
- typedef struct uct_iface_addr uct_iface_addr_t
- typedef struct uct_ep_addr uct_ep_addr_t
- typedef struct uct_ep_params uct_ep_params_t
- typedef struct uct_ep_connect_params uct_ep_connect_params_t
- typedef struct uct_cm_attr uct_cm_attr_t
- typedef struct uct_cm uct_cm_t
- typedef uct_cm_t ∗ uct_cm_h
- typedef struct uct_listener_attr uct_listener_attr_t
- typedef struct uct_listener ∗ uct_listener_h
- typedef struct uct_listener_params uct_listener_params_t
- typedef struct uct_tag_context uct_tag_context_t
- typedef uint64_t uct_tag_t
- typedef int uct_worker_cb_id_t
- typedef void ∗ uct_conn_request_h
- typedef struct uct_iov uct_iov_t

  Structure for scatter-gather I/O.
- typedef void(∗ uct_completion_callback_t) (uct_completion_t ∗self)

  Callback to process send completion.
- typedef ucs_status_t(∗ uct_pending_callback_t) (uct_pending_req_t ∗self)

  Callback to process pending requests.
- typedef ucs_status_t(∗ uct_error_handler_t) (void ∗arg, uct_ep_h ep, ucs_status_t status)

  Callback to process peer failure.
- typedef void(∗ uct_pending_purge_callback_t) (uct_pending_req_t ∗self, void ∗arg)

  Callback to purge pending requests.
- typedef size_t(∗ uct_pack_callback_t) (void ∗dest, void ∗arg)

  Callback for producing data.
- typedef void(∗ uct_unpack_callback_t) (void ∗arg, const void ∗data, size_t length)

  Callback for consuming data.
- typedef void(∗ uct_async_event_cb_t) (void ∗arg, unsigned flags)

  Callback to process asynchronous events.

Enumerations

- enum uct_component_attr_field { UCT_COMPONENT_ATTR_FIELD_NAME = UCS_BIT(0), UCT_COMPONENT_ATTR_FIEL
= UCS_BIT(1), UCT_COMPONENT_ATTR_FIELD_MD_RESOURCES = UCS_BIT(2), UCT_COMPONENT_ATTR_FIELD_FL
= UCS_BIT(3) }

  UCT component attributes field mask.
- enum { UCT_COMPONENT_FLAG_CM = UCS_BIT(0), UCT_COMPONENT_FLAG_RKEY_PTR = UCS_↩
BIT(1) }

  Capability flags of uct_component_h.
- enum uct_device_type_t {
UCT_DEVICE_TYPE_NET, UCT_DEVICE_TYPE_SHM, UCT_DEVICE_TYPE_ACC, UCT_DEVICE_TYPE_SELF,
UCT_DEVICE_TYPE_LAST }

  List of UCX device types.
- enum uct_iface_event_types { UCT_EVENT_SEND_COMP = UCS_BIT(0), UCT_EVENT_RECV = UCS_↩
BIT(1), UCT_EVENT_RECV_SIG = UCS_BIT(2) }

  Asynchronous event types.
- enum uct_flush_flags { UCT_FLUSH_FLAG_LOCAL = 0, UCT_FLUSH_FLAG_CANCEL = UCS_BIT(0),
UCT_FLUSH_FLAG_REMOTE = UCS_BIT(1) }

  Flush modifiers.
- enum uct_progress_types { UCT_PROGRESS_SEND = UCS_BIT(0), UCT_PROGRESS_RECV = UCS_↩
BIT(1), UCT_PROGRESS_THREAD_SAFE = UCS_BIT(7) }

  UCT progress types.
- enum uct_cb_flags { UCT_CB_FLAG_RESERVED = UCS_BIT(1), UCT_CB_FLAG_ASYNC = UCS_BIT(2) }

  Callback flags.
- enum uct_iface_open_mode { UCT_IFACE_OPEN_MODE_DEVICE = UCS_BIT(0), UCT_IFACE_OPEN_MODE_SOCKADDR
= UCS_BIT(1), UCT_IFACE_OPEN_MODE_SOCKADDR_CLIENT = UCS_BIT(2) }

  Mode in which to open the interface.
- enum uct_iface_params_field {
UCT_IFACE_PARAM_FIELD_CPU_MASK = UCS_BIT(0), UCT_IFACE_PARAM_FIELD_OPEN_MODE =
UCS_BIT(1), UCT_IFACE_PARAM_FIELD_DEVICE = UCS_BIT(2), UCT_IFACE_PARAM_FIELD_SOCKADDR
= UCS_BIT(3),
UCT_IFACE_PARAM_FIELD_STATS_ROOT = UCS_BIT(4), UCT_IFACE_PARAM_FIELD_RX_HEADROOM
= UCS_BIT(5), UCT_IFACE_PARAM_FIELD_ERR_HANDLER_ARG = UCS_BIT(6), UCT_IFACE_PARAM_FIELD_ERR_HAN
= UCS_BIT(7),
UCT_IFACE_PARAM_FIELD_ERR_HANDLER_FLAGS = UCS_BIT(8), UCT_IFACE_PARAM_FIELD_HW_TM_EAGER_ARG
= UCS_BIT(9), UCT_IFACE_PARAM_FIELD_HW_TM_EAGER_CB = UCS_BIT(10), UCT_IFACE_PARAM_FIELD_HW_TM_F
= UCS_BIT(11),
UCT_IFACE_PARAM_FIELD_HW_TM_RNDV_CB = UCS_BIT(12), UCT_IFACE_PARAM_FIELD_ASYNC_EVENT_ARG
= UCS_BIT(13), UCT_IFACE_PARAM_FIELD_ASYNC_EVENT_CB = UCS_BIT(14), UCT_IFACE_PARAM_FIELD_KEEPALI
= UCS_BIT(15),
UCT_IFACE_PARAM_FIELD_AM_ALIGNMENT = UCS_BIT(16), UCT_IFACE_PARAM_FIELD_AM_ALIGN_OFFSET
= UCS_BIT(17), UCT_IFACE_PARAM_FIELD_FEATURES = UCS_BIT(18) }

  UCT interface created by uct_iface_open parameters field mask.
- enum uct_ep_params_field {
UCT_EP_PARAM_FIELD_IFACE = UCS_BIT(0), UCT_EP_PARAM_FIELD_USER_DATA = UCS_BIT(1),
UCT_EP_PARAM_FIELD_DEV_ADDR = UCS_BIT(2), UCT_EP_PARAM_FIELD_IFACE_ADDR = UCS_↩
BIT(3),
UCT_EP_PARAM_FIELD_SOCKADDR = UCS_BIT(4), UCT_EP_PARAM_FIELD_SOCKADDR_CB_FLAGS
= UCS_BIT(5), UCT_EP_PARAM_FIELD_SOCKADDR_PACK_CB = UCS_BIT(6), UCT_EP_PARAM_FIELD_CM
= UCS_BIT(7),
UCT_EP_PARAM_FIELD_CONN_REQUEST = UCS_BIT(8), UCT_EP_PARAM_FIELD_SOCKADDR_CONNECT_CB_CLIEN
= UCS_BIT(9), UCT_EP_PARAM_FIELD_SOCKADDR_NOTIFY_CB_SERVER = UCS_BIT(10), UCT_EP_PARAM_FIELD_SC
= UCS_BIT(11),
UCT_EP_PARAM_FIELD_PATH_INDEX = UCS_BIT(12), UCT_EP_PARAM_FIELD_CM_RESOLVE_CB =
UCS_BIT(13), UCT_EP_PARAM_FIELD_PRIV_DATA = UCS_BIT(14), UCT_EP_PARAM_FIELD_PRIV_DATA_LENGTH
= UCS_BIT(15),

UCT_EP_PARAM_FIELD_LOCAL_SOCKADDR = UCS_BIT(16), UCT_EP_PARAM_FIELD_DEV_ADDR_LENGTH = UCS_BIT(17), UCT_EP_PARAM_FIELD_IFACE_ADDR_LENGTH = UCS_BIT(18) }

UCT endpoint created by uct_ep_create parameters field mask.

- enum uct_iface_feature {
UCT_IFACE_FEATURE_AM = UCS_BIT(0), UCT_IFACE_FEATURE_PUT = UCS_BIT(1), UCT_IFACE_FEATURE_GET = UCS_BIT(2), UCT_IFACE_FEATURE_AMO32 = UCS_BIT(3),
UCT_IFACE_FEATURE_AMO64 = UCS_BIT(4), UCT_IFACE_FEATURE_TAG = UCS_BIT(5), UCT_IFACE_FEATURE_FLUS
= UCS_BIT(6), UCT_IFACE_FEATURE_LAST = UCS_BIT(7) }

  UCT interface configuration features.
- enum { UCT_TAG_RECV_CB_INLINE_DATA = UCS_BIT(0) }

  flags of uct_tag_context.
- enum uct_cb_param_flags { UCT_CB_PARAM_FLAG_DESC = UCS_BIT(0), UCT_CB_PARAM_FLAG_FIRST = UCS_BIT(1), UCT_CB_PARAM_FLAG_MORE = UCS_BIT(2) }

  Flags for active message and tag-matching offload callbacks (callback's parameters).

Functions

- ucs_status_t uct_query_components (uct_component_h ∗∗components_p, unsigned ∗num_components_p)

  Query for list of components.
- void uct_release_component_list (uct_component_h ∗components)

  Release the list of components returned from uct_query_components.
- ucs_status_t uct_component_query (uct_component_h component, uct_component_attr_t ∗component_attr)

  Get component attributes.
- ucs_status_t uct_md_open (uct_component_h component, const char ∗md_name, const uct_md_config_t ∗config, uct_md_h ∗md_p)

  Open a memory domain.
- void uct_md_close (uct_md_h md)

  Close a memory domain.
- ucs_status_t uct_md_query_tl_resources (uct_md_h md, uct_tl_resource_desc_t ∗∗resources_p, unsigned ∗num_resources_p)

  Query for transport resources.
- void uct_release_tl_resource_list (uct_tl_resource_desc_t ∗resources)

  Release the list of resources returned from uct_md_query_tl_resources.
- ucs_status_t uct_md_iface_config_read (uct_md_h md, const char ∗tl_name, const char ∗env_prefix, const char ∗filename, uct_iface_config_t ∗∗config_p)

  Read transport-specific interface configuration.
- void uct_config_release (void ∗config)

  Release configuration memory returned from uct_md_iface_config_read(), uct_md_config_read(), or from uct_cm_config_read().
- ucs_status_t uct_iface_open (uct_md_h md, uct_worker_h worker, const uct_iface_params_t ∗params, const uct_iface_config_t ∗config, uct_iface_h ∗iface_p)

  Open a communication interface.
- void uct_iface_close (uct_iface_h iface)

  Close and destroy an interface.
- ucs_status_t uct_iface_query (uct_iface_h iface, uct_iface_attr_t ∗iface_attr)

  Get interface attributes.
- ucs_status_t uct_iface_get_device_address (uct_iface_h iface, uct_device_addr_t ∗addr)

  Get address of the device the interface is using.
- ucs_status_t uct_iface_get_address (uct_iface_h iface, uct_iface_addr_t ∗addr)

  Get interface address.
- int uct_iface_is_reachable (const uct_iface_h iface, const uct_device_addr_t ∗dev_addr, const uct_iface_addr_t ∗iface_addr)

Check if remote iface address is reachable.
- ucs_status_t uct_ep_check (const uct_ep_h ep, unsigned flags, uct_completion_t ∗comp)

  check if the destination endpoint is alive in respect to UCT library
- ucs_status_t uct_iface_event_fd_get (uct_iface_h iface, int ∗fd_p)

  Obtain a notification file descriptor for polling.
- ucs_status_t uct_iface_event_arm (uct_iface_h iface, unsigned events)

  Turn on event notification for the next event.
- ucs_status_t uct_iface_mem_alloc (uct_iface_h iface, size_t length, unsigned flags, const char ∗name, uct_allocated_memory_t ∗mem)

  Allocate memory which can be used for zero-copy communications.
- void uct_iface_mem_free (const uct_allocated_memory_t ∗mem)

  Release memory allocated with uct_iface_mem_alloc().
- ucs_status_t uct_ep_create (const uct_ep_params_t ∗params, uct_ep_h ∗ep_p)

  Create new endpoint.
- void uct_ep_destroy (uct_ep_h ep)

  Destroy an endpoint.
- ucs_status_t uct_ep_get_address (uct_ep_h ep, uct_ep_addr_t ∗addr)

  Get endpoint address.
- ucs_status_t uct_ep_connect_to_ep (uct_ep_h ep, const uct_device_addr_t ∗dev_addr, const uct_ep_addr_t ∗ep_addr)

  Connect endpoint to a remote endpoint.
- ucs_status_t uct_iface_flush (uct_iface_h iface, unsigned flags, uct_completion_t ∗comp)

  Flush outstanding communication operations on an interface.
- ucs_status_t uct_iface_fence (uct_iface_h iface, unsigned flags)

  Ensures ordering of outstanding communications on the interface. Operations issued on the interface prior to this call are guaranteed to be completed before any subsequent communication operations to the same interface which follow the call to fence.
- ucs_status_t uct_ep_pending_add (uct_ep_h ep, uct_pending_req_t ∗req, unsigned flags)

  Add a pending request to an endpoint.
- void uct_ep_pending_purge (uct_ep_h ep, uct_pending_purge_callback_t cb, void ∗arg)

  Remove all pending requests from an endpoint.
- ucs_status_t uct_ep_flush (uct_ep_h ep, unsigned flags, uct_completion_t ∗comp)

  Flush outstanding communication operations on an endpoint.
- ucs_status_t uct_ep_fence (uct_ep_h ep, unsigned flags)

  Ensures ordering of outstanding communications on the endpoint. Operations issued on the endpoint prior to this call are guaranteed to be completed before any subsequent communication operations to the same endpoint which follow the call to fence.
- void uct_iface_progress_enable (uct_iface_h iface, unsigned flags)

  Enable synchronous progress for the interface.
- void uct_iface_progress_disable (uct_iface_h iface, unsigned flags)

  Disable synchronous progress for the interface.
- unsigned uct_iface_progress (uct_iface_h iface)

  Perform a progress on an interface.
- static UCS_F_ALWAYS_INLINE void uct_completion_update_status (uct_completion_t ∗comp, ucs_status_t status)

  Update status of UCT completion handle.

6.11.1 Detailed Description

This section describes a concept of the Communication Resource and routines associated with the concept.

6.11.2 Data Structure Documentation

6.11.2.1 struct uct_md_resource_desc

This structure describes a memory domain resource.

Data Fields

char	md_name[UCT_MD_NAME_MAX]	Memory domain name

6.11.2.2 struct uct_component_attr

This structure defines the attributes for UCT component. It is used for uct_component_query

Examples:

uct_hello_world.c.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_component_attr_field. Fields not specified in this mask will be ignored. Provides ABI compatibility with respect to adding new fields.
char	name[UCT_COMPONENT_NAME_MAX]	Component name
unsigned	md_resource_count	Number of memory-domain resources
uct_md_resource_desc_t ∗	md_resources	Array of memory domain resources. When used, it should be initialized prior to calling uct_component_query with a pointer to an array, which is large enough to hold all memory domain resource entries. After the call, this array will be filled with information about existing memory domain resources. In order to allocate this array, you can call uct_component_query twice: The first time would only obtain the amount of entries required, by specifying UCT_COMPONENT_ATTR_FIELD_MD_RESOURCE_CO in field_mask. Then the array could be allocated with the returned number of entries, and passed to a second call to uct_component_query, this time setting field_mask to UCT_COMPONENT_ATTR_FIELD_MD_RESOURCES.
uint64_t	flags	Flags as defined by UCT_COMPONENT_FLAG_xx.

6.11.2.3 struct uct_tl_resource_desc

Resource descriptor is an object representing the network resource. Resource descriptor could represent a stand-alone communication resource such as an HCA port, network interface, or multiple resources such as multiple network interfaces or communication ports. It could also represent virtual communication resources that are defined over a single physical network interface.

Examples:

uct_hello_world.c.

Data Fields

char	tl_name[UCT_TL_NAME_MAX]	Transport name
char	dev_name[UCT_DEVICE_NAME_MAX]	Hardware device name
uct_device_type_t	dev_type	The device represented by this resource (e.g. UCT_DEVICE_TYPE_NET for a network interface)
ucs_sys_device_t	sys_device	The identifier associated with the device bus_id as captured in ucs_sys_bus_id_t struct

6.11.2.4 struct uct_iface_attr

Examples:

uct_hello_world.c.

Data Fields

struct uct_iface_attr	cap	Interface capabilities
size_t	device_addr_len	Size of device address
size_t	iface_addr_len	Size of interface address
size_t	ep_addr_len	Size of endpoint address
size_t	max_conn_priv	Max size of the iface's private data. used for connection establishment with sockaddr
struct sockaddr_storage	listen_sockaddr	Sockaddr on which this iface is listening.
double	overhead	Message overhead, seconds
uct_ppn_bandwidth_t	bandwidth	Bandwidth model
ucs_linear_func_t	latency	Latency as function of number of active endpoints
uint8_t	priority	Priority of device
size_t	max_num_eps	Maximum number of endpoints
unsigned	dev_num_paths	How many network paths can be utilized on the device used by this interface for optimal performance. Endpoints that connect to the same remote address but use different paths can potentially achieve higher total bandwidth compared to using only a single endpoint.

6.11.2.5 struct uct_iface_attr.cap

Data Fields

cap	put	Attributes for PUT operations
cap	get	Attributes for GET operations
cap	am	Attributes for AM operations
cap	tag	Attributes for TAG operations
cap	atomic32	
cap	atomic64	Attributes for atomic operations
uint64_t	flags	Flags from UCT interface operations and capabilities
uint64_t	event_flags	Flags from UCT interface for asynchronous event capabilities

6.11.2.6 struct uct_iface_attr.cap.put

Data Fields

size_t	max_short	Maximal size for put_short
size_t	max_bcopy	Maximal size for put_bcopy
size_t	min_zcopy	Minimal size for put_zcopy (total of uct_iov_t::length of the *iov* parameter)
size_t	max_zcopy	Maximal size for put_zcopy (total of uct_iov_t::length of the *iov* parameter)
size_t	opt_zcopy_align	Optimal alignment for zero-copy buffer address
size_t	align_mtu	MTU used for alignment
size_t	max_iov	Maximal *iovcnt* parameter in uct_ep_put_zcopy

6.11.2.7 struct uct_iface_attr.cap.get

Data Fields

size_t	max_short	Maximal size for get_short
size_t	max_bcopy	Maximal size for get_bcopy
size_t	min_zcopy	Minimal size for get_zcopy (total of uct_iov_t::length of the *iov* parameter)
size_t	max_zcopy	Maximal size for get_zcopy (total of uct_iov_t::length of the *iov* parameter)
size_t	opt_zcopy_align	Optimal alignment for zero-copy buffer address
size_t	align_mtu	MTU used for alignment
size_t	max_iov	Maximal *iovcnt* parameter in uct_ep_get_zcopy

6.11.2.8 struct uct_iface_attr.cap.am

Data Fields

size_t	max_short	Total maximum size (incl. the header)
size_t	max_bcopy	Total maximum size (incl. the header)
size_t	min_zcopy	Minimal size for am_zcopy (incl. the header and total of uct_iov_t::length of the *iov* parameter)
size_t	max_zcopy	Total max. size (incl. the header and total of uct_iov_t::length of the *iov* parameter)
size_t	opt_zcopy_align	Optimal alignment for zero-copy buffer address
size_t	align_mtu	MTU used for alignment
size_t	max_hdr	Max. header size for zcopy
size_t	max_iov	Maximal *iovcnt* parameter in uct_ep_am_zcopy

6.11.2.9 struct uct_iface_attr.cap.tag

Data Fields

tag	recv	
tag	eager	Attributes related to eager protocol
tag	rndv	Attributes related to rendezvous protocol

6.11.2.10 struct uct_iface_attr.cap.tag.recv

Data Fields

size_t	min_recv	Minimal allowed length of posted receive buffer
size_t	max_zcopy	Maximal allowed data length in uct_iface_tag_recv_zcopy
size_t	max_iov	Maximal *iovcnt* parameter in uct_iface_tag_recv_zcopy
size_t	max_outstanding	Maximal number of simultaneous receive operations

6.11.2.11 struct uct_iface_attr.cap.tag.eager

Data Fields

size_t	max_short	Maximal allowed data length in uct_ep_tag_eager_short
size_t	max_bcopy	Maximal allowed data length in uct_ep_tag_eager_bcopy
size_t	max_zcopy	Maximal allowed data length in uct_ep_tag_eager_zcopy
size_t	max_iov	Maximal *iovcnt* parameter in uct_ep_tag_eager_zcopy

6.11.2.12 struct uct_iface_attr.cap.tag.rndv

Data Fields

size_t	max_zcopy	Maximal allowed data length in uct_ep_tag_rndv_zcopy
size_t	max_hdr	Maximal allowed header length in uct_ep_tag_rndv_zcopy and uct_ep_tag_rndv_request
size_t	max_iov	Maximal *iovcnt* parameter in uct_ep_tag_rndv_zcopy

6.11.2.13 struct uct_iface_attr.cap.atomic32

Data Fields

uint64_t	op_flags	Attributes for atomic-post operations
uint64_t	fop_flags	Attributes for atomic-fetch operations

6.11.2.14 struct uct_iface_attr.cap.atomic64

Data Fields

uint64_t	op_flags	Attributes for atomic-post operations
uint64_t	fop_flags	Attributes for atomic-fetch operations

6.11.2.15 struct uct_iface_params

This structure should be allocated by the user and should be passed to uct_iface_open. User has to initialize all fields of this structure.

Examples:

uct_hello_world.c.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_iface_params_field. Fields not specified in this mask will be ignored.
ucs_cpu_set_t	cpu_mask	Mask of CPUs to use for resources
uint64_t	open_mode	Interface open mode bitmap. uct_iface_open_mode
union uct_iface_params	mode	Mode-specific parameters
ucs_stats_node_t ∗	stats_root	Root in the statistics tree. Can be NULL. If non NULL, it will be a root of *uct_iface* object in the statistics tree.
size_t	rx_headroom	How much bytes to reserve before the receive segment.
void ∗	err_handler_arg	Custom argument of *err_handler*.
uct_error_handler_t	err_handler	The callback to handle transport level error.
uint32_t	err_handler_flags	Callback flags to indicate where the *err_handler* callback can be invoked from. uct_cb_flags
void ∗	eager_arg	These callbacks are only relevant for HW Tag Matching
uct_tag_unexp_eager_cb_t	eager_cb	Callback for tag matching unexpected eager messages
void ∗	rndv_arg	
uct_tag_unexp_rndv_cb_t	rndv_cb	Callback for tag matching unexpected rndv messages
void ∗	async_event_arg	
uct_async_event_cb_t	async_event_cb	Callback for asynchronous event handling. The callback will be invoked from UCT transport when there are new events to be read by user if the iface has UCT_IFACE_FLAG_EVENT_ASYNC_CB capability
ucs_time_t	keepalive_interval	
size_t	am_alignment	Desired alignment for Active Messages on the receiver. Note that only data received in the UCT descriptor can be aligned (i.e. *UCT_CB_PARAM_FLAG_DESC* flag is provided in the Active Message handler callback). The provided value must be power of 2. The default value is 1.
size_t	am_align_offset	Offset in the Active Message receive buffer, which should be aligned to the *am_alignment* boundary. Note this parameter has no effect without setting *am_alignment* parameter. The provided value must be less than the given *am_alignment* value. The default value is 0. +-+ pointer to *data* in uct_am_callback_t | | + alignment boundary | | v v +-----------------—+ | align | | | offset | | +-----------------—+
uint64_t	features	UCT features that are used for interface initialization.

6.11.2.16 union uct_iface_params.mode

Mode-specific parameters

Data Fields

mode	device	The fields in this structure (tl_name and dev_name) need to be set only when the UCT_IFACE_OPEN_MODE_DEVICE bit is set in uct_iface_params_t::open_mode This will make uct_iface_open open the interface on the specified device.
mode	sockaddr	These callbacks and address are only relevant for client-server connection establishment with sockaddr and are needed on the server side. The callbacks and address need to be set when the UCT_IFACE_OPEN_MODE_SOCKADDR_SERVER bit is set in uct_iface_params_t::open_mode. This will make uct_iface_open open the interface on the specified address as a server.

6.11.2.17 struct uct_iface_params.mode.device

The fields in this structure (tl_name and dev_name) need to be set only when the UCT_IFACE_OPEN_MODE_DEVICE bit is set in uct_iface_params_t::open_mode This will make uct_iface_open open the interface on the specified device.

Data Fields

const char ∗	tl_name	Transport name
const char ∗	dev_name	Device Name

6.11.2.18 struct uct_iface_params.mode.sockaddr

These callbacks and address are only relevant for client-server connection establishment with sockaddr and are needed on the server side. The callbacks and address need to be set when the UCT_IFACE_OPEN_MODE_SOCKADDR_SERVER bit is set in uct_iface_params_t::open_mode. This will make uct_iface_open open the interface on the specified address as a server.

Data Fields

ucs_sock_addr_t	listen_sockaddr	
void ∗	conn_request_arg	Argument for connection request callback
uct_sockaddr_conn_request_callback_t	conn_request_cb	Callback for an incoming connection request on the server
uint32_t	cb_flags	Callback flags to indicate where the callback can be invoked from. uct_cb_flags

6.11.2.19 struct uct_ep_params

Examples:

uct_hello_world.c.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_ep_params_field. Fields not specified by this mask will be ignored.

Data Fields

uct_iface_h	iface	Interface to create the endpoint on. Either *iface* or *cm* field must be initialized but not both.
void ∗	user_data	User data associated with the endpoint.
const uct_device_addr_t ∗	dev_addr	The device address to connect to on the remote peer. This must be defined together with uct_ep_params_t::iface_addr to create an endpoint connected to a remote interface.
const uct_iface_addr_t ∗	iface_addr	This specifies the remote address to use when creating an endpoint that is connected to a remote interface. Note This requires UCT_IFACE_FLAG_CONNECT_TO_IFACE capability.
const ucs_sock_addr_t ∗	sockaddr	The sockaddr to connect to on the remote peer. If set, uct_ep_create will create an endpoint for a connection to the remote peer, specified by its socket address. Note The interface in this routine requires the UCT_IFACE_FLAG_CONNECT_TO_SOCKADDR capability.
uint32_t	sockaddr_cb_flags	uct_cb_flags to indicate uct_ep_params_t::sockaddr_pack_cb, uct_ep_params_t::sockaddr_cb_client, uct_ep_params_t::sockaddr_cb_server, uct_ep_params_t::disconnect_cb and uct_ep_params_t::cm_resolve_cb behavior. If none from these are not set, this field will be ignored.
uct_cm_ep_priv_data_pack_callback_t	sockaddr_pack_cb	Callback that will be used for filling the user's private data to be delivered to the remote peer by the callback on the server or client side. This field is only valid if uct_ep_params_t::sockaddr is set. Note It is never guaranteed that the callback will be called. If, for example, the endpoint goes into error state before issuing the connection request, the callback will not be invoked. Can not be set together with uct_ep_params_t::private_data or uct_ep_params_t::cm_resolve_cb.

Data Fields

uct_cm_h	cm	The connection manager object as created by uct_cm_open. Either *cm* or *iface* field must be initialized but not both.
uct_conn_request_h	conn_request	Connection request that was passed to uct_cm_listener_conn_request_args_t::conn_request. **Note** After a call to uct_ep_create, *params.conn_request* is consumed and should not be used anymore, even if the call returns with an error.
uct_cm_ep_client_connect_callback_t	sockaddr_cb_client	Callback that will be invoked when the endpoint on the client side is being connected to the server by a connection manager uct_cm_h .
uct_cm_ep_server_conn_notify_callback_t	sockaddr_cb_server	Callback that will be invoked when the endpoint on the server side is being connected to a client by a connection manager uct_cm_h .
uct_ep_disconnect_cb_t	disconnect_cb	Callback that will be invoked when the endpoint is disconnected.
unsigned	path_index	Index of the path which the endpoint should use, must be in the range 0..(uct_iface_attr_t::dev_num_paths - 1).
uct_cm_ep_resolve_callback_t	cm_resolve_cb	This callback is invoked when the remote server address provided in field uct_ep_params_t::sockaddr is resolved to the local device to be used for connection establishment. **Note** This field is mutually exclusive with uct_ep_params::sockaddr_pack_cb.
const void ∗	private_data	Private data to be passed from server to client. Can be used only along with uct_ep_params::conn_request. **Note** This field is mutually exclusive with uct_ep_params::sockaddr_pack_cb.
size_t	private_data_length	Length of uct_ep_params::private_data, the maximal allowed value is indicated by the uct_cm_attr::max_conn_priv.
const ucs_sock_addr_t ∗	local_sockaddr	The sockaddr to bind locally. If set, uct_ep_create will create an endpoint binding to this local sockaddr. **Note** The interface in this routine requires the UCT_IFACE_FLAG_CONNECT_TO_SOCKADDR capability.

Data Fields

size_t	dev_addr_length	Device address length. If not provided, the transport will assume a default minimum length according to the address buffer contents.
size_t	iface_addr_length	Iface address length. If not provided, the transport will assume a default minimum length according to the address buffer contents.

6.11.2.20 struct uct_completion

This structure should be allocated by the user and can be passed to communication primitives. The user must initialize all fields of the structure. If the operation returns UCS_INPROGRESS, this structure will be in use by the transport until the operation completes. When the operation completes, "count" field is decremented by 1, and whenever it reaches 0 - the callback is called.

Notes:

- The same structure can be passed multiple times to communication functions without the need to wait for completion.
- If the number of operations is smaller than the initial value of the counter, the callback will not be called at all, so it may be left undefined.
- status field is required to track the first time the error occurred, and report it via a callback when count reaches 0.

Examples:

uct_hello_world.c.

Data Fields

uct_completion_callback_t	func	User callback function
int	count	Completion counter
ucs_status_t	status	Completion status, this field must be initialized with UCS_OK before first operation is started.

6.11.2.21 struct uct_pending_req

This structure should be passed to uct_ep_pending_add() and is used to signal new available resources back to user.

Data Fields

uct_pending_callback_t	func	User callback function
char	priv[UCT_PENDING_REQ_PRIV_LEN]	Used internally by UCT

6.11.2.22 struct uct_iov

Specifies a list of buffers which can be used within a single data transfer function call.

```
buffer
|
+-----------+-------+-----------+-------+-----------+
|  payload  | empty |  payload  | empty |  payload  |
+-----------+-------+-----------+-------+-----------+
|<-length-->|       |<-length-->|       |<-length-->|
|<---- stride ----->|<---- stride ----->|
```

Note

The sum of lengths in all iov list must be less or equal to max_zcopy of the respective communication operation.
If *length* or *count* are zero, the memory pointed to by *buffer* will not be accessed. Otherwise, *buffer* must point to valid memory.
If *count* is one, every iov entry specifies a single contiguous data block
If *count* $>$ 1, each iov entry specifies a strided block of *count* elements and distance of *stride* byte between consecutive elements

Examples:

uct_hello_world.c.

Data Fields

void ∗	buffer	Data buffer
size_t	length	Length of the payload in bytes
uct_mem_h	memh	Local memory key descriptor for the data
size_t	stride	Stride between beginnings of payload elements in the buffer in bytes
unsigned	count	Number of payload elements in the buffer

6.11.3 Typedef Documentation

6.11.3.1 uct_md_resource_desc_t

```
typedef struct uct_md_resource_desc uct_md_resource_desc_t
```

This structure describes a memory domain resource.

6.11.3.2 uct_component_attr_t

```
typedef struct uct_component_attr uct_component_attr_t
```

This structure defines the attributes for UCT component. It is used for uct_component_query

6.11.3.3 uct_tl_resource_desc_t

```
typedef struct uct_tl_resource_desc uct_tl_resource_desc_t
```

Resource descriptor is an object representing the network resource. Resource descriptor could represent a standalone communication resource such as an HCA port, network interface, or multiple resources such as multiple network interfaces or communication ports. It could also represent virtual communication resources that are defined over a single physical network interface.

6.11.3.4 uct_component_h

```
typedef struct uct_component* uct_component_h
```

6.11.3.5 uct_iface_h

```
typedef struct uct_iface* uct_iface_h
```

6.11.3.6 uct_iface_config_t

```
typedef struct uct_iface_config uct_iface_config_t
```

6.11.3.7 uct_md_config_t

```
typedef struct uct_md_config uct_md_config_t
```

6.11.3.8 uct_cm_config_t

```
typedef struct uct_cm_config uct_cm_config_t
```

6.11.3.9 uct_ep_h

```
typedef struct uct_ep* uct_ep_h
```

6.11.3.10 uct_mem_h

```
typedef void* uct_mem_h
```

6.11.3.11 uct_rkey_t

```
typedef uintptr_t uct_rkey_t
```

6.11.3.12 uct_md_h

```
typedef struct uct_md* uct_md_h
```

6.11.3.13 uct_md_ops_t

```
typedef struct uct_md_ops uct_md_ops_t
```

6.11.3.14 uct_rkey_ctx_h

```
typedef void* uct_rkey_ctx_h
```

6.11.3.15 uct_iface_attr_t

```
typedef struct uct_iface_attr uct_iface_attr_t
```

6.11.3.16 uct_iface_params_t

```
typedef struct uct_iface_params uct_iface_params_t
```

6.11.3.17 uct_ep_attr_t

```
typedef struct uct_ep_attr uct_ep_attr_t
```

6.11.3.18 uct_md_attr_t

```
typedef struct uct_md_attr uct_md_attr_t
```

6.11.3.19 uct_completion_t

```
typedef struct uct_completion uct_completion_t
```

6.11.3.20 uct_pending_req_t

```
typedef struct uct_pending_req uct_pending_req_t
```

6.11.3.21 uct_worker_h

```
typedef struct uct_worker* uct_worker_h
```

6.11.3.22 uct_md_t

```
typedef struct uct_md uct_md_t
```

6.11.3.23 uct_am_trace_type_t

```
typedef enum uct_am_trace_type uct_am_trace_type_t
```

6.11.3.24 uct_device_addr_t

```
typedef struct uct_device_addr uct_device_addr_t
```

6.11.3.25 uct_iface_addr_t

```
typedef struct uct_iface_addr uct_iface_addr_t
```

6.11.3.26 uct_ep_addr_t

```
typedef struct uct_ep_addr uct_ep_addr_t
```

6.11.3.27 uct_ep_params_t

```
typedef struct uct_ep_params uct_ep_params_t
```

6.11.3.28 uct_ep_connect_params_t

```
typedef struct uct_ep_connect_params uct_ep_connect_params_t
```

6.11.3.29 uct_cm_attr_t

```
typedef struct uct_cm_attr uct_cm_attr_t
```

6.11.3.30 uct_cm_t

```
typedef struct uct_cm uct_cm_t
```

6.11.3.31 uct_cm_h

```
typedef uct_cm_t* uct_cm_h
```

6.11.3.32 uct_listener_attr_t

```
typedef struct uct_listener_attr uct_listener_attr_t
```

6.11.3.33 uct_listener_h

```
typedef struct uct_listener* uct_listener_h
```

6.11.3.34 uct_listener_params_t

```
typedef struct uct_listener_params uct_listener_params_t
```

6.11.3.35 uct_tag_context_t

```
typedef struct uct_tag_context uct_tag_context_t
```

6.11.3.36 uct_tag_t

```
typedef uint64_t uct_tag_t
```

6.11.3.37 uct_worker_cb_id_t

```
typedef int uct_worker_cb_id_t
```

6.11.3.38 uct_conn_request_h

```
typedef void* uct_conn_request_h
```

6.11.3.39 uct_iov_t

```
typedef struct uct_iov uct_iov_t
```

Specifies a list of buffers which can be used within a single data transfer function call.

```
 buffer
 |
 +-----------+-------+-----------+-------+-----------+
 |  payload  | empty |  payload  | empty |  payload  |
 +-----------+-------+-----------+-------+-----------+
 |<-length-->|       |<-length-->|       |<-length-->|
 |<---- stride ----->|<---- stride ----->|
```

Note

The sum of lengths in all iov list must be less or equal to max_zcopy of the respective communication operation.
If *length* or *count* are zero, the memory pointed to by *buffer* will not be accessed. Otherwise, *buffer* must point to valid memory.
If *count* is one, every iov entry specifies a single contiguous data block
If *count* $>$ 1, each iov entry specifies a strided block of *count* elements and distance of *stride* byte between consecutive elements

6.11.3.40 uct_completion_callback_t

```
typedef void(* uct_completion_callback_t) (uct_completion_t *self)
```

Parameters

in	*self*	Pointer to relevant completion structure, which was initially passed to the operation.

6.11.3.41 uct_pending_callback_t

```
typedef ucs_status_t(* uct_pending_callback_t) (uct_pending_req_t *self)
```

Parameters

in	*self*	Pointer to relevant pending structure, which was initially passed to the operation.

Returns

UCS_OK - This pending request has completed and should be removed. UCS_INPROGRESS - Some progress was made, but not completed. Keep this request and keep processing the queue. Otherwise - Could not make any progress. Keep this pending request on the queue, and stop processing the queue.

6.11.3.42 uct_error_handler_t

```
typedef ucs_status_t(* uct_error_handler_t) (void *arg, uct_ep_h ep, ucs_status_t status)
```

Note

User should purge a pending queue and do not post any TX operations and cancel all possible outstanding operations prior closing a UCT endpoint.

Parameters

in	*arg*	User argument to be passed to the callback.
in	*ep*	Endpoint which has failed. Upon return from the callback, this *ep* is no longer usable and all subsequent operations on this *ep* will fail with the error code passed in *status*.
in	*status*	Status indicating error.

Returns

UCS_OK - The error was handled successfully. Otherwise - The error was not handled and is returned back to the transport.

6.11.3.43 uct_pending_purge_callback_t

```
typedef void(* uct_pending_purge_callback_t) (uct_pending_req_t *self, void *arg)
```

Parameters

in	*self*	Pointer to relevant pending structure, which was initially passed to the operation.
in	*arg*	User argument to be passed to the callback.

6.11.3.44 uct_pack_callback_t

```
typedef size_t(* uct_pack_callback_t) (void *dest, void *arg)
```

Parameters

in	*dest*	Memory buffer to pack the data to.
in	*arg*	Custom user-argument.

Returns

Size of the data was actually produced.

6.11.3.45 uct_unpack_callback_t

```
typedef void(* uct_unpack_callback_t) (void *arg, const void *data, size_t length)
```

Parameters

in	*arg*	Custom user-argument.

Parameters

in	*data*	Memory buffer to unpack the data from.
in	*length*	How much data to consume (size of "data")

Note

The arguments for this callback are in the same order as libc's memcpy().

6.11.3.46 uct_async_event_cb_t

```
typedef void(* uct_async_event_cb_t) (void *arg, unsigned flags)
```

Parameters

in	*arg*	User argument to be passed to the callback.
in	*flags*	Flags to be passed to the callback (reserved for future use).

6.11.4 Enumeration Type Documentation

6.11.4.1 uct_component_attr_field

```
enum uct_component_attr_field
```

The enumeration allows specifying which fields in uct_component_attr_t are present. It is used for backward compatibility support.

Enumerator

UCT_COMPONENT_ATTR_FIELD_NAME	Component name
UCT_COMPONENT_ATTR_FIELD_MD_RESOURCE_COUNT	MD resource count
UCT_COMPONENT_ATTR_FIELD_MD_RESOURCES	MD resources array
UCT_COMPONENT_ATTR_FIELD_FLAGS	Capability flags

6.11.4.2 anonymous enum

```
anonymous enum
```

The enumeration defines bit mask of uct_component_h capabilities in uct_component_attr_t::flags which is set by uct_component_query.

Enumerator

UCT_COMPONENT_FLAG_CM	If set, the component supports uct_cm_h functionality. See uct_cm_open for details.

Enumerator

UCT_COMPONENT_FLAG_RKEY_PTR	If set, the component supports direct access to remote memory using a local pointer returned from uct_rkey_ptr function.

6.11.4.3 uct_device_type_t

```
enum uct_device_type_t
```

Enumerator

UCT_DEVICE_TYPE_NET	Network devices
UCT_DEVICE_TYPE_SHM	Shared memory devices
UCT_DEVICE_TYPE_ACC	Acceleration devices
UCT_DEVICE_TYPE_SELF	Loop-back device
UCT_DEVICE_TYPE_LAST	

6.11.4.4 uct_iface_event_types

```
enum uct_iface_event_types
```

Note

The UCT_EVENT_RECV and UCT_EVENT_RECV_SIG event types are used to indicate receive-side completions for both tag matching and active messages. If the interface supports signaled receives (UCT_IFACE_FLAG_EVENT_RECV_SIG), then for the messages sent with UCT_SEND_FLAG_SIGNALED flag, UCT_EVENT_RECV_SIG should be triggered on the receiver. Otherwise, UCT_EVENT_RECV should be triggered.

Enumerator

UCT_EVENT_SEND_COMP	Send completion event
UCT_EVENT_RECV	Tag or active message received
UCT_EVENT_RECV_SIG	Signaled tag or active message received

6.11.4.5 uct_flush_flags

```
enum uct_flush_flags
```

Enumerator

UCT_FLUSH_FLAG_LOCAL	Guarantees that the data transfer is completed but the target buffer may not be updated yet.

Enumerator

UCT_FLUSH_FLAG_CANCEL	The library will make a best effort attempt to cancel all uncompleted operations. However, there is a chance that some operations will not be canceled in which case the user will need to handle their completions through the relevant callbacks. After uct_ep_flush with this flag is completed, the endpoint will be set to error state, and it becomes unusable for send operations and should be destroyed.
UCT_FLUSH_FLAG_REMOTE	Guarantees that all previous UCP memory update operations (put, atomics, etc.) are completed, the target memory of these operation was updated, and the updated memory is globally visible for all processing elements in the system.

6.11.4.6 uct_progress_types

```
enum uct_progress_types
```

Enumerator

UCT_PROGRESS_SEND	Progress send operations
UCT_PROGRESS_RECV	Progress receive operations
UCT_PROGRESS_THREAD_SAFE	Enable/disable progress while another thread may be calling ucp_worker_progress().

6.11.4.7 uct_cb_flags

```
enum uct_cb_flags
```

List of flags for a callback.

Enumerator

UCT_CB_FLAG_RESERVED	Reserved for future use.
UCT_CB_FLAG_ASYNC	Callback is allowed to be called from any thread in the process, and therefore should be thread-safe. For example, it may be called from a transport async progress thread. To guarantee async invocation, the interface must have the UCT_IFACE_FLAG_CB_ASYNC flag set. If async callback is requested on an interface which only supports sync callback (i.e., only the UCT_IFACE_FLAG_CB_SYNC flag is set), the callback will be invoked only from the context that called uct_iface_progress).

6.11.4.8 uct_iface_open_mode

```
enum uct_iface_open_mode
```

Enumerator

UCT_IFACE_OPEN_MODE_DEVICE	Interface is opened on a specific device

Enumerator

UCT_IFACE_OPEN_MODE_SOCKADDR_SERVER	Interface is opened on a specific address on the server side. This mode will be deprecated in the near future for a better API.
UCT_IFACE_OPEN_MODE_SOCKADDR_CLIENT	Interface is opened on a specific address on the client side This mode will be deprecated in the near future for a better API.

6.11.4.9 uct_iface_params_field

`enum uct_iface_params_field`

The enumeration allows specifying which fields in uct_iface_params_t are present, for backward compatibility support.

Enumerator

UCT_IFACE_PARAM_FIELD_CPU_MASK	Enables uct_iface_params_t::cpu_mask
UCT_IFACE_PARAM_FIELD_OPEN_MODE	Enables uct_iface_params_t::open_mode
UCT_IFACE_PARAM_FIELD_DEVICE	Enables uct_iface_params_t::mode::device
UCT_IFACE_PARAM_FIELD_SOCKADDR	Enables uct_iface_params_t::mode::sockaddr
UCT_IFACE_PARAM_FIELD_STATS_ROOT	Enables uct_iface_params_t::stats_root
UCT_IFACE_PARAM_FIELD_RX_HEADROOM	Enables uct_iface_params_t::rx_headroom
UCT_IFACE_PARAM_FIELD_ERR_HANDLER_ARG	Enables uct_iface_params_t::err_handler_arg
UCT_IFACE_PARAM_FIELD_ERR_HANDLER	Enables uct_iface_params_t::err_handler
UCT_IFACE_PARAM_FIELD_ERR_HANDLER_FLAGS	Enables uct_iface_params_t::err_handler_flags
UCT_IFACE_PARAM_FIELD_HW_TM_EAGER_ARG	Enables uct_iface_params_t::eager_arg
UCT_IFACE_PARAM_FIELD_HW_TM_EAGER_CB	Enables uct_iface_params_t::eager_cb
UCT_IFACE_PARAM_FIELD_HW_TM_RNDV_ARG	Enables uct_iface_params_t::rndv_arg
UCT_IFACE_PARAM_FIELD_HW_TM_RNDV_CB	Enables uct_iface_params_t::rndv_cb
UCT_IFACE_PARAM_FIELD_ASYNC_EVENT_ARG	Enables uct_iface_params_t::async_event_arg
UCT_IFACE_PARAM_FIELD_ASYNC_EVENT_CB	Enables uct_iface_params_t::async_event_cb
UCT_IFACE_PARAM_FIELD_KEEPALIVE_INTERVAL	Enables uct_iface_params_t::keepalive_interval
UCT_IFACE_PARAM_FIELD_AM_ALIGNMENT	Enables uct_iface_params_t::am_alignment
UCT_IFACE_PARAM_FIELD_AM_ALIGN_OFFSET	Enables uct_iface_params_t::am_align_offset
UCT_IFACE_PARAM_FIELD_FEATURES	Enables uct_iface_params_t::features

6.11.4.10 uct_ep_params_field

`enum uct_ep_params_field`

The enumeration allows specifying which fields in uct_ep_params_t are present, for backward compatibility support.

Enumerator

UCT_EP_PARAM_FIELD_IFACE	Enables uct_ep_params::iface
UCT_EP_PARAM_FIELD_USER_DATA	Enables uct_ep_params::user_data

Enumerator

UCT_EP_PARAM_FIELD_DEV_ADDR	Enables uct_ep_params::dev_addr
UCT_EP_PARAM_FIELD_IFACE_ADDR	Enables uct_ep_params::iface_addr
UCT_EP_PARAM_FIELD_SOCKADDR	Enables uct_ep_params::sockaddr
UCT_EP_PARAM_FIELD_SOCKADDR_CB_FLAGS	Enables uct_ep_params::sockaddr_cb_flags
UCT_EP_PARAM_FIELD_SOCKADDR_PACK_CB	Enables uct_ep_params::sockaddr_pack_cb
UCT_EP_PARAM_FIELD_CM	Enables uct_ep_params::cm
UCT_EP_PARAM_FIELD_CONN_REQUEST	Enables uct_ep_params::conn_request
UCT_EP_PARAM_FIELD_SOCKADDR_CONNECT_CB_↵ CLIENT	Enables uct_ep_params::sockaddr_cb_client
UCT_EP_PARAM_FIELD_SOCKADDR_NOTIFY_CB_SE↵ RVER	Enables uct_ep_params::sockaddr_cb_server
UCT_EP_PARAM_FIELD_SOCKADDR_DISCONNECT_CB	Enables uct_ep_params::disconnect_cb
UCT_EP_PARAM_FIELD_PATH_INDEX	Enables uct_ep_params::path_index
UCT_EP_PARAM_FIELD_CM_RESOLVE_CB	Enables uct_ep_params::cm_resolve_cb
UCT_EP_PARAM_FIELD_PRIV_DATA	Enables uct_ep_params::private_data
UCT_EP_PARAM_FIELD_PRIV_DATA_LENGTH	Enables uct_ep_params::private_data_length
UCT_EP_PARAM_FIELD_LOCAL_SOCKADDR	Enables uct_ep_params::local_sockaddr
UCT_EP_PARAM_FIELD_DEV_ADDR_LENGTH	Enables uct_ep_params::dev_addr_length
UCT_EP_PARAM_FIELD_IFACE_ADDR_LENGTH	Enables uct_ep_params::iface_addr_length

6.11.4.11 uct_iface_feature

`enum uct_iface_feature`

The enumeration list describes the features supported by UCT. An application can request the features using UCT parameters during UCT iface initialization process.

Enumerator

UCT_IFACE_FEATURE_AM	Request Active Message support
UCT_IFACE_FEATURE_PUT	Request PUT support
UCT_IFACE_FEATURE_GET	Request GET support
UCT_IFACE_FEATURE_AMO32	Request 32-bit atomic operations support
UCT_IFACE_FEATURE_AMO64	Request 64-bit atomic operations support
UCT_IFACE_FEATURE_TAG	Request tag matching offload support
UCT_IFACE_FEATURE_FLUSH_REMOTE	Request remote flush support
UCT_IFACE_FEATURE_LAST	Used to determine the number of features

6.11.4.12 anonymous enum

`anonymous enum`

Enumerator

UCT_TAG_RECV_CB_INLINE_DATA	

6.11.4.13 uct_cb_param_flags

```
enum uct_cb_param_flags
```

If UCT_CB_PARAM_FLAG_DESC flag is enabled, then data is part of a descriptor which includes the user-defined rx_headroom, and the callback may return UCS_INPROGRESS and hold on to that descriptor. Otherwise, the data can't be used outside the callback. If needed, the data must be copied-out.

```
 descriptor    data
 |             |
 +-------------+-------------------------+
 | rx_headroom | payload                 |
 +-------------+-------------------------+
```

UCT_CB_PARAM_FLAG_FIRST and UCT_CB_PARAM_FLAG_MORE flags are relevant for uct_tag_unexp_eager_cb_t callback only. The former value indicates that the data is the first fragment of the message. The latter value means that more fragments of the message yet to be delivered.

Enumerator

UCT_CB_PARAM_FLAG_DESC	
UCT_CB_PARAM_FLAG_FIRST	
UCT_CB_PARAM_FLAG_MORE	

6.11.5 Function Documentation

6.11.5.1 uct_query_components()

```
ucs_status_t uct_query_components (
             uct_component_h ** components_p,
             unsigned * num_components_p )
```

Obtain the list of transport components available on the current system.

Parameters

out	*components_p*	Filled with a pointer to an array of component handles.
out	*num_components↩_p*	Filled with the number of elements in the array.

Returns

UCS_OK if successful, or UCS_ERR_NO_MEMORY if failed to allocate the array of component handles.

Examples:

uct_hello_world.c.

6.11.5.2 uct_release_component_list()

```
void uct_release_component_list (
            uct_component_h * components )
```

This routine releases the memory associated with the list of components allocated by uct_query_components.

Parameters

in	*components*	Array of component handles to release.

Examples:

uct_hello_world.c.

6.11.5.3 uct_component_query()

```
ucs_status_t uct_component_query (
            uct_component_h component,
            uct_component_attr_t * component_attr )
```

Query various attributes of a component.

Parameters

in	*component*	Component handle to query attributes for. The handle can be obtained from uct_query_components.
in,out	*component_attr*	Filled with component attributes.

Returns

UCS_OK if successful, or nonzero error code in case of failure.

Examples:

uct_hello_world.c.

6.11.5.4 uct_md_open()

```
ucs_status_t uct_md_open (
            uct_component_h component,
            const char * md_name,
            const uct_md_config_t * config,
            uct_md_h * md_p )
```

Open a specific memory domain. All communications and memory operations are performed in the context of a specific memory domain. Therefore it must be created before communication resources.

Parameters

in	*component*	Component on which to open the memory domain, as returned from uct_query_components.

Parameters

in	*md_name*	Memory domain name, as returned from uct_component_query.
in	*config*	MD configuration options. Should be obtained from uct_md_config_read() function, or point to MD-specific structure which extends uct_md_config_t.
out	*md_p*	Filled with a handle to the memory domain.

Returns

Error code.

Examples:

uct_hello_world.c.

6.11.5.5 uct_md_close()

```
void uct_md_close (
            uct_md_h md )
```

Parameters

in	*md*	Memory domain to close.

Examples:

uct_hello_world.c.

6.11.5.6 uct_md_query_tl_resources()

```
ucs_status_t uct_md_query_tl_resources (
            uct_md_h md,
            uct_tl_resource_desc_t ** resources_p,
            unsigned * num_resources_p )
```

This routine queries the memory domain for communication resources that are available for it.

Parameters

in	*md*	Handle to memory domain.
out	*resources_p*	Filled with a pointer to an array of resource descriptors.
out	*num_resources↵_p*	Filled with the number of resources in the array.

Returns

Error code.

Examples:

uct_hello_world.c.

6.11.5.7 uct_release_tl_resource_list()

```
void uct_release_tl_resource_list (
            uct_tl_resource_desc_t * resources )
```

This routine releases the memory associated with the list of resources allocated by uct_md_query_tl_resources.

Parameters

in	*resources*	Array of resource descriptors to release.

Examples:

uct_hello_world.c.

6.11.5.8 uct_md_iface_config_read()

```
ucs_status_t uct_md_iface_config_read (
            uct_md_h md,
            const char * tl_name,
            const char * env_prefix,
            const char * filename,
            uct_iface_config_t ** config_p )
```

Parameters

in	*md*	Memory domain on which the transport's interface was registered.
in	*tl_name*	Transport name. If *md* supports UCT_MD_FLAG_SOCKADDR, the transport name is allowed to be NULL. In this case, the configuration returned from this routine should be passed to uct_iface_open with UCT_IFACE_OPEN_MODE_SOCKADDR_SERVER or UCT_IFACE_OPEN_MODE_SOCKADDR_CLIENT set in uct_iface_params_t::open_mode. In addition, if tl_name is not NULL, the configuration returned from this routine should be passed to uct_iface_open with UCT_IFACE_OPEN_MODE_DEVICE set in uct_iface_params_t::open_mode.
in	*env_prefix*	If non-NULL, search for environment variables starting with this UCT_<prefix>_. Otherwise, search for environment variables starting with just UCT_.
in	*filename*	If non-NULL, read configuration from this file. If the file does not exist, it will be ignored.
out	*config_p*	Filled with a pointer to configuration.

Returns

Error code.

Examples:

uct_hello_world.c.

6.11.5.9 uct_config_release()

```
void uct_config_release (
            void * config )
```

Parameters

in	*config*	Configuration to release.

Examples:

uct_hello_world.c.

6.11.5.10 uct_iface_open()

```
ucs_status_t uct_iface_open (
            uct_md_h md,
            uct_worker_h worker,
            const uct_iface_params_t * params,
            const uct_iface_config_t * config,
            uct_iface_h * iface_p )
```

Parameters

in	*md*	Memory domain to create the interface on.
in	*worker*	Handle to worker which will be used to progress communications on this interface.
in	*params*	User defined uct_iface_params_t parameters.
in	*config*	Interface configuration options. Should be obtained from uct_md_iface_config_read() function, or point to transport-specific structure which extends uct_iface_config_t.
out	*iface←_p*	Filled with a handle to opened communication interface.

Returns

Error code.

Examples:

uct_hello_world.c.

6.11.5.11 uct_iface_close()

```
void uct_iface_close (
            uct_iface_h iface )
```

Parameters

in	*iface*	Interface to close.

Examples:

uct_hello_world.c.

6.11.5.12 uct_iface_query()

```
ucs_status_t uct_iface_query (
            uct_iface_h iface,
            uct_iface_attr_t * iface_attr )
```

Parameters

in	*iface*	Interface to query.
out	*iface_attr*	Filled with interface attributes.

Examples:

uct_hello_world.c.

6.11.5.13 uct_iface_get_device_address()

```
ucs_status_t uct_iface_get_device_address (
            uct_iface_h iface,
            uct_device_addr_t * addr )
```

Get underlying device address of the interface. All interfaces using the same device would return the same address.

Parameters

in	*iface*	Interface to query.
out	*addr*	Filled with device address. The size of the buffer provided must be at least uct_iface_attr_t::device_addr_len.

Examples:

uct_hello_world.c.

6.11.5.14 uct_iface_get_address()

```
ucs_status_t uct_iface_get_address (
            uct_iface_h iface,
            uct_iface_addr_t * addr )
```

requires UCT_IFACE_FLAG_CONNECT_TO_IFACE.

Parameters

in	*iface*	Interface to query.
out	*addr*	Filled with interface address. The size of the buffer provided must be at least uct_iface_attr_t::iface_addr_len.

Examples:

uct_hello_world.c.

6.11.5.15 uct_iface_is_reachable()

```
int uct_iface_is_reachable (
            const uct_iface_h iface,
            const uct_device_addr_t * dev_addr,
            const uct_iface_addr_t * iface_addr )
```

This function checks if a remote address can be reached from a local interface. If the function returns true, it does not necessarily mean a connection and/or data transfer would succeed, since the reachability check is a local operation it does not detect issues such as network mis-configuration or lack of connectivity.

Parameters

in	*iface*	Interface to check reachability from.
in	*dev_addr*	Device address to check reachability to. It is NULL if iface_attr.dev_addr_len == 0, and must be non-NULL otherwise.
in	*iface_addr*	Interface address to check reachability to. It is NULL if iface_attr.iface_addr_len == 0, and must be non-NULL otherwise.

Returns

Nonzero if reachable, 0 if not.

Examples:

uct_hello_world.c.

6.11.5.16 uct_ep_check()

```
ucs_status_t uct_ep_check (
            const uct_ep_h ep,
            unsigned flags,
            uct_completion_t * comp )
```

This function checks if the destination endpoint is alive with respect to the UCT library. If the status of *ep* is known, either UCS_OK or an error is returned immediately. Otherwise, UCS_INPROGRESS is returned, indicating that synchronization on the status is needed. In this case, the status will be be propagated by *comp* callback.

Parameters

in	*ep*	Endpoint to check
in	*flags*	Flags that define level of check (currently unsupported - set to 0).
in	*comp*	Handler to process status of *ep*

Returns

Error code.

6.11.5.17 uct_iface_event_fd_get()

```
ucs_status_t uct_iface_event_fd_get (
              uct_iface_h iface,
              int * fd_p )
```

Only interfaces that support at least one of the UCT_IFACE_FLAG_EVENT∗ flags will implement this function.

Parameters

in	*iface*	Interface to get the notification descriptor.
out	*fd_p*	Location to write the notification file descriptor.

Returns

Error code.

6.11.5.18 uct_iface_event_arm()

```
ucs_status_t uct_iface_event_arm (
              uct_iface_h iface,
              unsigned events )
```

This routine needs to be called before waiting on each notification on this interface, so will typically be called once the processing of the previous event is over.

Parameters

in	*iface*	Interface to arm.
in	*events*	Events to wakeup on. See uct_iface_event_types

Returns

UCS_OK The operation completed successfully. File descriptor will be signaled by new events.
UCS_ERR_BUSY There are unprocessed events which prevent the file descriptor from being armed. The operation is not completed. File descriptor will not be signaled by new events.
Other different error codes in case of issues.

6.11.5.19 uct_iface_mem_alloc()

```
ucs_status_t uct_iface_mem_alloc (
              uct_iface_h iface,
              size_t length,
              unsigned flags,
              const char * name,
              uct_allocated_memory_t * mem )
```

Allocate a region of memory which can be used for zero-copy data transfer or remote access on a particular transport interface.

Parameters

in	*iface*	Interface to allocate memory on.
in	*length*	Size of memory region to allocate.
in	*flags*	Memory allocation flags, see uct_md_mem_flags.
in	*name*	Allocation name, for debug purposes.
out	*mem*	Descriptor of allocated memory.

Returns

UCS_OK if allocation was successful, error code otherwise.

6.11.5.20 uct_iface_mem_free()

```
void uct_iface_mem_free (
            const uct_allocated_memory_t * mem )
```

Parameters

in	*mem*	Descriptor of memory to release.

6.11.5.21 uct_ep_create()

```
ucs_status_t uct_ep_create (
            const uct_ep_params_t * params,
            uct_ep_h * ep_p )
```

Create a UCT endpoint in one of the available modes:

1. Unconnected endpoint: If no any address is present in uct_ep_params, this creates an unconnected endpoint. To establish a connection to a remote endpoint, uct_ep_connect_to_ep will need to be called. Use of this mode requires uct_ep_params_t::iface has the UCT_IFACE_FLAG_CONNECT_TO_EP capability flag. It may be obtained by uct_iface_query.
2. Connect to a remote interface: If uct_ep_params_t::dev_addr and uct_ep_params_t::iface_addr are set, this will establish an endpoint that is connected to a remote interface. This requires that uct_ep_params_t::iface has the UCT_IFACE_FLAG_CONNECT_TO_IFACE capability flag. It may be obtained by uct_iface_query.
3. Connect to a remote socket address: If uct_ep_params_t::sockaddr is set, this will create an endpoint that is connected to a remote socket. This requires that either uct_ep_params::cm, or uct_ep_params::iface will be set. In the latter case, the interface has to support UCT_IFACE_FLAG_CONNECT_TO_SOCKADDR flag, which can be checked by calling uct_iface_query.

Parameters

in	*params*	User defined uct_ep_params_t configuration for the *ep_p*.
out	*ep_p*	Filled with handle to the new endpoint.

Returns

UCS_OK The endpoint is created successfully. This does not guarantee that the endpoint has been connected to the destination defined in *params*; in case of failure, the error will be reported to the interface error handler callback provided to uct_iface_open via uct_iface_params_t::err_handler.
Error code as defined by ucs_status_t

Examples:

uct_hello_world.c.

6.11.5.22 uct_ep_destroy()

```
void uct_ep_destroy (
            uct_ep_h ep )
```

Parameters

in	*ep*	Endpoint to destroy.

Examples:

uct_hello_world.c.

6.11.5.23 uct_ep_get_address()

```
ucs_status_t uct_ep_get_address (
            uct_ep_h ep,
            uct_ep_addr_t * addr )
```

Parameters

in	*ep*	Endpoint to query.
out	*addr*	Filled with endpoint address. The size of the buffer provided must be at least uct_iface_attr_t::ep_addr_len.

Examples:

uct_hello_world.c.

6.11.5.24 uct_ep_connect_to_ep()

```
ucs_status_t uct_ep_connect_to_ep (
            uct_ep_h ep,
            const uct_device_addr_t * dev_addr,
            const uct_ep_addr_t * ep_addr )
```

requires UCT_IFACE_FLAG_CONNECT_TO_EP capability.

Parameters

in	*ep*	Endpoint to connect.
in	*dev_addr*	Remote device address.
in	*ep_addr*	Remote endpoint address.

Examples:

uct_hello_world.c.

6.11.5.25 uct_iface_flush()

```
ucs_status_t uct_iface_flush (
            uct_iface_h iface,
            unsigned flags,
            uct_completion_t * comp )
```

Flushes all outstanding communications issued on the interface prior to this call. The operations are completed at the origin or at the target as well. The exact completion semantic depends on *flags* parameter.

Note

Currently only one completion type is supported. It guarantees that the data transfer is completed but the target buffer may not be updated yet.

Parameters

in	*iface*	Interface to flush communications from.
in	*flags*	Flags that control completion semantic (currently only UCT_FLUSH_FLAG_LOCAL is supported).
in,out	*comp*	Completion handle as defined by uct_completion_t. Can be NULL, which means that the call will return the current state of the interface and no completion will be generated in case of outstanding communications. If it is not NULL completion counter is decremented by 1 when the call completes. Completion callback is called when the counter reaches 0.

Returns

UCS_OK - No outstanding communications left. UCS_INPROGRESS - Some communication operations are still in progress. If non-NULL 'comp' is provided, it will be updated upon completion of these operations.

6.11.5.26 uct_iface_fence()

```
ucs_status_t uct_iface_fence (
            uct_iface_h iface,
            unsigned flags )
```

Parameters

in	*iface*	Interface to issue communications from.
in	*flags*	Flags that control ordering semantic (currently unsupported - set to 0).

Returns

UCS_OK - Ordering is inserted.

6.11.5.27 uct_ep_pending_add()

```
ucs_status_t uct_ep_pending_add (
             uct_ep_h ep,
             uct_pending_req_t * req,
             unsigned flags )
```

Add a pending request to the endpoint pending queue. The request will be dispatched when the endpoint could potentially have additional send resources.

Parameters

in	*ep*	Endpoint to add the pending request to.
in	*req*	Pending request, which would be dispatched when more resources become available. The user is expected to initialize the "func" field. After being passed to the function, the request is owned by UCT, until the callback is called and returns UCS_OK.
in	*flags*	Flags that control pending request processing (see uct_cb_flags)

Returns

UCS_OK - request added to pending queue UCS_ERR_BUSY - request was not added to pending queue, because send resources are available now. The user is advised to retry.

6.11.5.28 uct_ep_pending_purge()

```
void uct_ep_pending_purge (
             uct_ep_h ep,
             uct_pending_purge_callback_t cb,
             void * arg )
```

Remove pending requests from the given endpoint and pass them to the provided callback function. The callback return value is ignored.

Parameters

in	*ep*	Endpoint to remove pending requests from.
in	*cb*	Callback to pass the removed requests to.
in	*arg*	Argument to pass to the *cb* callback.

6.11.5.29 uct_ep_flush()

```
ucs_status_t uct_ep_flush (
             uct_ep_h ep,
             unsigned flags,
             uct_completion_t * comp )
```

Flushes all outstanding communications issued on the endpoint prior to this call. The operations are completed at the origin or at the target as well. The exact completion semantic depends on *flags* parameter.

Parameters

in	*ep*	Endpoint to flush communications from.
in	*flags*	Flags uct_flush_flags that control completion semantic.
in,out	*comp*	Completion handle as defined by uct_completion_t. Can be NULL, which means that the call will return the current state of the endpoint and no completion will be generated in case of outstanding communications. If it is not NULL completion counter is decremented by 1 when the call completes. Completion callback is called when the counter reaches 0.

Returns

UCS_OK - No outstanding communications left. UCS_ERR_NO_RESOURCE - Flush operation could not be initiated. A subsequent call to uct_ep_pending_add would add a pending operation, which provides an opportunity to retry the flush. UCS_INPROGRESS - Some communication operations are still in progress. If non-NULL 'comp' is provided, it will be updated upon completion of these operations.

6.11.5.30 uct_ep_fence()

```
ucs_status_t uct_ep_fence (
            uct_ep_h ep,
            unsigned flags )
```

Parameters

in	*ep*	Endpoint to issue communications from.
in	*flags*	Flags that control ordering semantic (currently unsupported - set to 0).

Returns

UCS_OK - Ordering is inserted.

6.11.5.31 uct_iface_progress_enable()

```
void uct_iface_progress_enable (
            uct_iface_h iface,
            unsigned flags )
```

Notify the transport that it should actively progress communications during uct_worker_progress().

When the interface is created, its progress is initially disabled.

Parameters

in	*iface*	The interface to enable progress.
in	*flags*	The type of progress to enable as defined by uct_progress_types

Note

This function is not thread safe with respect to ucp_worker_progress(), unless the flag UCT_PROGRESS_THREAD_SAFE is specified.

Examples:

uct_hello_world.c.

6.11.5.32 uct_iface_progress_disable()

```
void uct_iface_progress_disable (
            uct_iface_h iface,
            unsigned flags )
```

Notify the transport that it should not progress its communications during uct_worker_progress(). Thus the latency of other transports may be improved.

By default, progress is disabled when the interface is created.

Parameters

in	*iface*	The interface to disable progress.
in	*flags*	The type of progress to disable as defined by uct_progress_types.

Note

This function is not thread safe with respect to ucp_worker_progress(), unless the flag UCT_PROGRESS_THREAD_SAFE is specified.

6.11.5.33 uct_iface_progress()

```
unsigned uct_iface_progress (
            uct_iface_h iface )
```

6.11.5.34 uct_completion_update_status()

```
static UCS_F_ALWAYS_INLINE void uct_completion_update_status (
            uct_completion_t * comp,
            ucs_status_t status )  [static]
```

Parameters

comp	[in] Completion handle to update.
status	[in] Status to update *comp* handle.

6.12 UCT Communication Context

Enumerations

- enum uct_alloc_method_t {
UCT_ALLOC_METHOD_THP, UCT_ALLOC_METHOD_MD, UCT_ALLOC_METHOD_HEAP, UCT_ALLOC_METHOD_MMAP
UCT_ALLOC_METHOD_HUGE, UCT_ALLOC_METHOD_LAST, UCT_ALLOC_METHOD_DEFAULT = U↩
CT_ALLOC_METHOD_LAST }

    Memory allocation methods.

Functions

- ucs_status_t uct_worker_create (ucs_async_context_t ∗async, ucs_thread_mode_t thread_mode, uct_worker_h ∗worker_p)

    Create a worker object.
- void uct_worker_destroy (uct_worker_h worker)

    Destroy a worker object.
- void uct_worker_progress_register_safe (uct_worker_h worker, ucs_callback_t func, void ∗arg, unsigned flags, uct_worker_cb_id_t ∗id_p)

    Add a slow path callback function to a worker progress.
- void uct_worker_progress_unregister_safe (uct_worker_h worker, uct_worker_cb_id_t ∗id_p)

    Remove a slow path callback function from worker's progress.
- ucs_status_t uct_config_get (void ∗config, const char ∗name, char ∗value, size_t max)

    Get value by name from interface configuration (uct_iface_config_t), memory domain configuration (uct_md_config_t) or connection manager configuration (uct_cm_config_t).
- ucs_status_t uct_config_modify (void ∗config, const char ∗name, const char ∗value)

    Modify interface configuration (uct_iface_config_t), memory domain configuration (uct_md_config_t) or connection manager configuration (uct_cm_config_t).
- unsigned uct_worker_progress (uct_worker_h worker)

    Explicit progress for UCT worker.

6.12.1 Detailed Description

UCT context abstracts all the resources required for network communication. It is designed to enable either share or isolate resources for multiple programming models used by an application.

This section provides a detailed description of this concept and routines associated with it.

6.12.2 Enumeration Type Documentation

6.12.2.1 uct_alloc_method_t

```
enum uct_alloc_method_t
```

Enumerator

UCT_ALLOC_METHOD_THP	Allocate from OS using libc allocator with Transparent Huge Pages enabled
UCT_ALLOC_METHOD_MD	Allocate using memory domain
UCT_ALLOC_METHOD_HEAP	Allocate from heap using libc allocator
UCT_ALLOC_METHOD_MMAP	Allocate from OS using mmap() syscall

Enumerator

UCT_ALLOC_METHOD_HUGE	Allocate huge pages
UCT_ALLOC_METHOD_LAST	
UCT_ALLOC_METHOD_DEFAULT	Use default method

6.12.3 Function Documentation

6.12.3.1 uct_worker_create()

```
ucs_status_t uct_worker_create (
            ucs_async_context_t * async,
            ucs_thread_mode_t thread_mode,
            uct_worker_h * worker_p )
```

The worker represents a progress engine. Multiple progress engines can be created in an application, for example to be used by multiple threads. Transports can allocate separate communication resources for every worker, so that every worker can be progressed independently of others.

Parameters

in	*async*	Context for async event handlers. Must not be NULL.
in	*thread_mode*	Thread access mode to the worker and all interfaces and endpoints associated with it.
out	*worker_p*	Filled with a pointer to the worker object.

Examples:

uct_hello_world.c.

6.12.3.2 uct_worker_destroy()

```
void uct_worker_destroy (
            uct_worker_h worker )
```

Parameters

in	*worker*	Worker object to destroy.

Examples:

uct_hello_world.c.

6.12.3.3 uct_worker_progress_register_safe()

```
void uct_worker_progress_register_safe (
            uct_worker_h worker,
            ucs_callback_t func,
            void * arg,
            unsigned flags,
            uct_worker_cb_id_t * id_p )
```

If ∗id_p is equal to UCS_CALLBACKQ_ID_NULL, this function will add a callback which will be invoked every time progress is made on the worker. ∗id_p will be updated with an id which refers to this callback and can be used in uct_worker_progress_unregister_safe to remove it from the progress path.

Parameters

in	*worker*	Handle to the worker whose progress should invoke the callback.
in	*func*	Pointer to the callback function.
in	*arg*	Argument for the callback function.
in	*flags*	Callback flags, see ucs_callbackq_flags.
in,out	*id_p*	Points to a location to store a callback identifier. If ∗id_p is equal to UCS_CALLBACKQ_ID_NULL, a callback will be added and ∗id_p will be replaced with a callback identifier which can be subsequently used to remove the callback. Otherwise, no callback will be added and ∗id_p will be left unchanged.

Note

This function is thread safe.

6.12.3.4 uct_worker_progress_unregister_safe()

```
void uct_worker_progress_unregister_safe (
            uct_worker_h worker,
            uct_worker_cb_id_t * id_p )
```

If ∗id_p is not equal to UCS_CALLBACKQ_ID_NULL, remove a callback which was previously added by uct_worker_progress_register_safe. ∗id_p will be reset to UCS_CALLBACKQ_ID_NULL.

Parameters

in	*worker*	Handle to the worker whose progress should invoke the callback.
in,out	*id_p*	Points to a callback identifier which indicates the callback to remove. If ∗id_p is not equal to UCS_CALLBACKQ_ID_NULL, the callback will be removed and ∗id_p will be reset to UCS_CALLBACKQ_ID_NULL. If ∗id_p is equal to UCS_CALLBACKQ_ID_NULL, no operation will be performed and ∗id_p will be left unchanged.

Note

This function is thread safe.

6.12.3.5 uct_config_get()

```
ucs_status_t uct_config_get (
            void * config,
            const char * name,
            char * value,
            size_t max )
```

Parameters

in	*config*	Configuration to get from.
in	*name*	Configuration variable name.
out	*value*	Pointer to get value. Should be allocated/freed by caller.
in	*max*	Available memory space at *value* pointer.

Returns

UCS_OK if found, otherwise UCS_ERR_INVALID_PARAM or UCS_ERR_NO_ELEM if error.

6.12.3.6 uct_config_modify()

```
ucs_status_t uct_config_modify (
              void * config,
              const char * name,
              const char * value )
```

Parameters

in	*config*	Configuration to modify.
in	*name*	Configuration variable name.
in	*value*	Value to set.

Returns

Error code.

6.12.3.7 uct_worker_progress()

```
unsigned uct_worker_progress (
              uct_worker_h worker )
```

This routine explicitly progresses any outstanding communication operations and active message requests.

Note

- In the current implementation, users **MUST** call this routine to receive the active message requests.

Parameters

in	*worker*	Handle to worker.

Returns

Nonzero if any communication was progressed, zero otherwise.

Examples:

uct_hello_world.c.

6.13 UCT Memory Domain

Data Structures

- struct uct_md_attr

  Memory domain attributes. More...
- struct uct_md_attr.cap
- struct uct_md_mem_attr

  Memory domain attributes. More...
- struct uct_allocated_memory

  Describes a memory allocated by UCT. More...
- struct uct_rkey_bundle

  Remote key with its type. More...
- struct uct_mem_alloc_params_t

  Parameters for allocating memory using uct_mem_alloc. More...
- struct uct_mem_alloc_params_t.mds

Typedefs

- typedef enum uct_md_mem_attr_field uct_md_mem_attr_field_t

  UCT MD memory attributes field mask.
- typedef struct uct_md_mem_attr uct_md_mem_attr_t

  Memory domain attributes.
- typedef struct uct_allocated_memory uct_allocated_memory_t

  Describes a memory allocated by UCT.
- typedef struct uct_rkey_bundle uct_rkey_bundle_t

  Remote key with its type.

Enumerations

- enum uct_sockaddr_accessibility_t { UCT_SOCKADDR_ACC_LOCAL, UCT_SOCKADDR_ACC_REMOTE }

  Socket address accessibility type.
- enum {
  UCT_MD_FLAG_ALLOC = UCS_BIT(0), UCT_MD_FLAG_REG = UCS_BIT(1), UCT_MD_FLAG_NEED_MEMH = UCS_BIT(2), UCT_MD_FLAG_NEED_RKEY = UCS_BIT(3),
  UCT_MD_FLAG_ADVISE = UCS_BIT(4), UCT_MD_FLAG_FIXED = UCS_BIT(5), UCT_MD_FLAG_RKEY_PTR = UCS_BIT(6), UCT_MD_FLAG_SOCKADDR = UCS_BIT(7),
  UCT_MD_FLAG_INVALIDATE = UCS_BIT(8), UCT_MD_FLAG_EXPORTED_MKEY = UCS_BIT(9),
  UCT_MD_FLAG_REG_DMABUF = UCS_BIT(10), UCT_MD_FLAG_LAST = UCS_BIT(11) }

  Memory domain capability flags.
- enum uct_md_mem_flags {
  UCT_MD_MEM_FLAG_NONBLOCK = UCS_BIT(0), UCT_MD_MEM_FLAG_FIXED = UCS_BIT(1),
  UCT_MD_MEM_FLAG_LOCK = UCS_BIT(2), UCT_MD_MEM_FLAG_HIDE_ERRORS = UCS_BIT(3),
  UCT_MD_MEM_ACCESS_REMOTE_PUT = UCS_BIT(5), UCT_MD_MEM_ACCESS_REMOTE_GET = UCS_BIT(6), UCT_MD_MEM_ACCESS_REMOTE_ATOMIC = UCS_BIT(7), UCT_MD_MEM_ACCESS_LOCAL_READ = UCS_BIT(8),
  UCT_MD_MEM_ACCESS_LOCAL_WRITE = UCS_BIT(9), UCT_MD_MEM_SYMMETRIC_RKEY = UCS↩
  _BIT(10), UCT_MD_MEM_GVA = UCS_BIT(11), UCT_MD_MEM_ACCESS_ALL,
  UCT_MD_MEM_ACCESS_RMA }

  Memory allocation/registration flags.
- enum uct_mem_advice_t { UCT_MADV_NORMAL = 0, UCT_MADV_WILLNEED }

list of UCT memory use advice

- enum uct_md_mem_attr_field {
UCT_MD_MEM_ATTR_FIELD_MEM_TYPE = UCS_BIT(0), UCT_MD_MEM_ATTR_FIELD_SYS_DEV = UCS_BIT(1), UCT_MD_MEM_ATTR_FIELD_BASE_ADDRESS = UCS_BIT(2), UCT_MD_MEM_ATTR_FIELD_ALLOC_LENG
= UCS_BIT(3),
UCT_MD_MEM_ATTR_FIELD_DMABUF_FD = UCS_BIT(4), UCT_MD_MEM_ATTR_FIELD_DMABUF_OFFSET
= UCS_BIT(5) }

  UCT MD memory attributes field mask.
- enum uct_mem_alloc_params_field_t {
UCT_MEM_ALLOC_PARAM_FIELD_FLAGS = UCS_BIT(0), UCT_MEM_ALLOC_PARAM_FIELD_ADDRESS
= UCS_BIT(1), UCT_MEM_ALLOC_PARAM_FIELD_MEM_TYPE = UCS_BIT(2), UCT_MEM_ALLOC_PARAM_FIELD_MDS
= UCS_BIT(3),
UCT_MEM_ALLOC_PARAM_FIELD_NAME = UCS_BIT(4) }

  UCT allocation parameters specification field mask.

Functions

- ucs_status_t uct_md_mem_query (uct_md_h md, const void ∗address, size_t length, uct_md_mem_attr_t ∗mem_attr)

  Query attributes of a given pointer.
- ucs_status_t uct_md_query (uct_md_h md, uct_md_attr_t ∗md_attr)

  Query for memory domain attributes.
- ucs_status_t uct_md_mem_advise (uct_md_h md, uct_mem_h memh, void ∗addr, size_t length, uct_mem_advice_t advice)

  Give advice about the use of memory.
- ucs_status_t uct_md_mem_reg (uct_md_h md, void ∗address, size_t length, unsigned flags, uct_mem_h ∗memh_p)

  Register memory for zero-copy sends and remote access.
- ucs_status_t uct_md_mem_dereg (uct_md_h md, uct_mem_h memh)

  Undo the operation of uct_md_mem_reg().
- ucs_status_t uct_md_detect_memory_type (uct_md_h md, const void ∗addr, size_t length, ucs_memory_type_t ∗mem_type_p)

  Detect memory type.
- ucs_status_t uct_mem_alloc (size_t length, const uct_alloc_method_t ∗methods, unsigned num_methods, const uct_mem_alloc_params_t ∗params, uct_allocated_memory_t ∗mem)

  Allocate memory for zero-copy communications and remote access.
- ucs_status_t uct_mem_free (const uct_allocated_memory_t ∗mem)

  Release allocated memory.
- ucs_status_t uct_md_config_read (uct_component_h component, const char ∗env_prefix, const char ∗filename, uct_md_config_t ∗∗config_p)

  Read the configuration for a memory domain.
- int uct_md_is_sockaddr_accessible (uct_md_h md, const ucs_sock_addr_t ∗sockaddr, uct_sockaddr_accessibility_t mode)

  Check if remote sock address is accessible from the memory domain.
- ucs_status_t uct_md_mkey_pack (uct_md_h md, uct_mem_h memh, void ∗rkey_buffer)

  Pack a remote key.
- ucs_status_t uct_rkey_unpack (uct_component_h component, const void ∗rkey_buffer, uct_rkey_bundle_t ∗rkey_ob)

  Unpack a remote key.
- ucs_status_t uct_rkey_ptr (uct_component_h component, uct_rkey_bundle_t ∗rkey_ob, uint64_t remote_↩
addr, void ∗∗addr_p)

  Get a local pointer to remote memory.
- ucs_status_t uct_rkey_release (uct_component_h component, const uct_rkey_bundle_t ∗rkey_ob)

  Release a remote key.

6.13.1 Detailed Description

The Memory Domain abstracts resources required for network communication, which typically includes memory, transport mechanisms, compute and network resources. It is an isolation mechanism that can be employed by the applications for isolating resources between multiple programming models. The attributes of the Memory Domain are defined by the structure uct_md_attr(). The communication and memory operations are defined in the context of Memory Domain.

6.13.2 Data Structure Documentation

6.13.2.1 struct uct_md_attr

This structure defines the attributes of a Memory Domain which includes maximum memory that can be allocated, credentials required for accessing the memory, CPU mask indicating the proximity of CPUs, and bitmaps indicating the types of memory (CPU/CUDA/ROCM) that can be detected, allocated and accessed.

Examples:

uct_hello_world.c.

Data Fields

struct uct_md_attr	cap	
ucs_linear_func_t	reg_cost	Memory registration cost estimation (time,seconds) as a linear function of the buffer size.
char	component_name[UCT_COMPONENT_NAME_MAX]	Component name
size_t	rkey_packed_size	Size of buffer needed for packed rkey
ucs_cpu_set_t	local_cpus	Mask of CPUs near the resource

6.13.2.2 struct uct_md_attr.cap

Data Fields

uint64_t	max_alloc	Maximal allocation size
size_t	max_reg	Maximal registration size
uint64_t	flags	UCT_MD_FLAG_xx
uint64_t	reg_mem_types	Bitmap of memory types that Memory Domain can be registered with
uint64_t	detect_mem_types	Bitmap of memory types that Memory Domain can detect if address belongs to it
uint64_t	alloc_mem_types	Bitmap of memory types that Memory Domain can allocate memory on
uint64_t	access_mem_types	Memory types that Memory Domain can access

6.13.2.3 struct uct_md_mem_attr

This structure defines the attributes of a memory pointer which may include the memory type of the pointer, and the system device that backs the pointer depending on the bit fields populated in field_mask.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_md_mem_attr_field_t.

Data Fields

ucs_memory_type_t	mem_type	The type of memory. E.g. CPU/GPU memory or some other valid type. If the md does not support sys_dev query, then UCS_MEMORY_TYPE_UNKNOWN is returned.
ucs_sys_device_t	sys_dev	Index of the system device on which the buffer resides. eg: NUMA/GPU If the md does not support sys_dev query, then UCS_SYS_DEVICE_ID_UNKNOWN is returned.
void ∗	base_address	Base address of the allocation to which the provided buffer belongs to. If the md not support base address query, then the pointer passed to uct_md_mem_query is returned as is.
size_t	alloc_length	Length of the whole allocation to which the provided buffer belongs to. If the md not support querying allocation length, then the length passed to uct_md_mem_query is returned as is.
int	dmabuf_fd	Dmabuf file descriptor to expose memory regions across devices. Refer (`https://01.↵ org/linuxgraphics/gfx-docs/drm/driver-api/dma-buf.↵ html`). If the md does not support querying the fd object associated with the region, then dmabuf_fd is set to UCT_DMABUF_FD_INVALID by uct_md_mem_query(). It is the responsibility of the user to close the returned fd using close (2) when it's no longer needed.
size_t	dmabuf_offset	Offset of the given address from the start of the memory region (identified by dmabuf_fd) backing the memory region being queried.

6.13.2.4 struct uct_allocated_memory

This structure describes the memory block which includes the address, size, and Memory Domain used for allocation. This structure is passed to interface and the memory is allocated by memory allocation functions uct_mem_alloc.

Data Fields

void ∗	address	Address of allocated memory
size_t	length	Real size of allocated memory
uct_alloc_method_t	method	Method used to allocate the memory
ucs_memory_type_t	mem_type	type of allocated memory
uct_md_h	md	if method==MD: MD used to allocate the memory
uct_mem_h	memh	if method==MD: MD memory handle

6.13.2.5 struct uct_rkey_bundle

This structure describes the credentials (typically key) and information required to access the remote memory by the communication interfaces.

Data Fields

uct_rkey_t	rkey	Remote key descriptor, passed to RMA functions
void ∗	handle	Handle, used internally for releasing the key
void ∗	type	Remote key type

6.13.2.6 struct uct_mem_alloc_params_t

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_mem_alloc_params_field_t. Fields not specified in this mask will be ignored.
unsigned	flags	Memory allocation flags, see uct_md_mem_flags If UCT_MEM_ALLOC_PARAM_FIELD_FLAGS is not specified in field_mask, then (UCT_MD_MEM_ACCESS_LOCAL_READ | UCT_MD_MEM_ACCESS_LOCAL_WRITE) is used by default.
void ∗	address	If *address* is NULL, the underlying allocation routine will choose the address at which to create the mapping. If *address* is non-NULL and UCT_MD_MEM_FLAG_FIXED is not set, the address will be interpreted as a hint as to where to establish the mapping. If *address* is non-NULL and UCT_MD_MEM_FLAG_FIXED is set, then the specified address is interpreted as a requirement. In this case, if the mapping to the exact address cannot be made, the allocation request fails.
ucs_memory_type_t	mem_type	Type of memory to be allocated.
struct uct_mem_alloc_params_t	mds	
const char ∗	name	Name of the allocated region, used to track memory usage for debugging and profiling. If UCT_MEM_ALLOC_PARAM_FIELD_NAME is not specified in field_mask, then "anonymous-uct_mem_alloc" is used by default.

6.13.2.7 struct uct_mem_alloc_params_t.mds

Data Fields

const uct_md_h ∗	mds	Array of memory domains to attempt to allocate the memory with, for MD allocation method.
unsigned	count	Length of 'mds' array. May be empty, in such case 'mds' may be NULL, and MD allocation method will be skipped.

6.13.3 Typedef Documentation

6.13.3.1 uct_md_mem_attr_field_t

```
typedef enum uct_md_mem_attr_field uct_md_mem_attr_field_t
```

The enumeration allows specifying which fields in uct_md_mem_attr_t are present.

6.13.3.2 uct_md_mem_attr_t

```
typedef struct uct_md_mem_attr uct_md_mem_attr_t
```

This structure defines the attributes of a memory pointer which may include the memory type of the pointer, and the system device that backs the pointer depending on the bit fields populated in field_mask.

6.13.3.3 uct_allocated_memory_t

```
typedef struct uct_allocated_memory uct_allocated_memory_t
```

This structure describes the memory block which includes the address, size, and Memory Domain used for allocation. This structure is passed to interface and the memory is allocated by memory allocation functions uct_mem_alloc.

6.13.3.4 uct_rkey_bundle_t

```
typedef struct uct_rkey_bundle uct_rkey_bundle_t
```

This structure describes the credentials (typically key) and information required to access the remote memory by the communication interfaces.

6.13.4 Enumeration Type Documentation

6.13.4.1 uct_sockaddr_accessibility_t

```
enum uct_sockaddr_accessibility_t
```

Enumerator

UCT_SOCKADDR_ACC_LOCAL	Check if local address exists. Address should belong to a local network interface
UCT_SOCKADDR_ACC_REMOTE	Check if remote address can be reached. Address is routable from one of the local network interfaces

6.13.4.2 anonymous enum

```
anonymous enum
```

Enumerator

UCT_MD_FLAG_ALLOC	MD supports memory allocation
UCT_MD_FLAG_REG	MD supports memory registration
UCT_MD_FLAG_NEED_MEMH	The transport needs a valid local memory handle for zero-copy operations
UCT_MD_FLAG_NEED_RKEY	The transport needs a valid remote memory key for remote memory operations
UCT_MD_FLAG_ADVISE	MD supports memory advice
UCT_MD_FLAG_FIXED	MD supports memory allocation with fixed address

Enumerator

UCT_MD_FLAG_RKEY_PTR	MD supports direct access to remote memory via a pointer that is returned by uct_rkey_ptr. **Note** This flag is deprecated and replaced by *UCT_COMPONENT_FLAG_RKEY_PTR*.
UCT_MD_FLAG_SOCKADDR	MD support for client-server connection establishment via sockaddr
UCT_MD_FLAG_INVALIDATE	MD supports memory invalidation. **Note** This flag is equivalent to the combination of UCT_MD_FLAG_INVALIDATE_RMA and UCT_MD_FLAG_INVALIDATE_AMO for uct_md_attr_v2_t.flags
UCT_MD_FLAG_EXPORTED_MKEY	MD supports exporting memory keys with another process using the same device or attaching to an exported memory key.
UCT_MD_FLAG_REG_DMABUF	MD supports registering a dmabuf file descriptor.
UCT_MD_FLAG_LAST	The enum must not be extended. Any additional flags must be defined in API v2 uct_md_flags_v2_t.

6.13.4.3 uct_md_mem_flags

```
enum uct_md_mem_flags
```

Enumerator

UCT_MD_MEM_FLAG_NONBLOCK	Hint to perform non-blocking allocation/registration: page mapping may be deferred until it is accessed by the CPU or a transport.
UCT_MD_MEM_FLAG_FIXED	Place the mapping at exactly defined address.
UCT_MD_MEM_FLAG_LOCK	Registered memory should be locked. May incur extra cost for registration, but memory access is usually faster.
UCT_MD_MEM_FLAG_HIDE_ERRORS	Hide errors on memory registration and allocation. If this flag is set, no error messages will be printed.
UCT_MD_MEM_ACCESS_REMOTE_PUT	Enable remote put access.
UCT_MD_MEM_ACCESS_REMOTE_GET	Enable remote get access.
UCT_MD_MEM_ACCESS_REMOTE_ATOMIC	Enable remote atomic access.
UCT_MD_MEM_ACCESS_LOCAL_READ	Enable local read access.
UCT_MD_MEM_ACCESS_LOCAL_WRITE	Enable local write access.
UCT_MD_MEM_SYMMETRIC_RKEY	Register the memory region so its remote access key would likely be equal to remote access keys received from other peers, when compared with *uct_rkey_compare*. This flag is a hint. When remote access keys received from different peers are compared equal, they can be used interchangeably, avoiding the need to keep all of them in memory.
UCT_MD_MEM_GVA	Register global VA to access all process virtual address space.

Enumerator

UCT_MD_MEM_ACCESS_ALL	Enable local and remote access for all operations.
UCT_MD_MEM_ACCESS_RMA	Enable local and remote access for put and get operations.

6.13.4.4 uct_mem_advice_t

`enum uct_mem_advice_t`

Enumerator

UCT_MADV_NORMAL	No special treatment
UCT_MADV_WILLNEED	can be used on the memory mapped with UCT_MD_MEM_FLAG_NONBLOCK to speed up memory mapping and to avoid page faults when the memory is accessed for the first time.

6.13.4.5 uct_md_mem_attr_field

`enum uct_md_mem_attr_field`

The enumeration allows specifying which fields in uct_md_mem_attr_t are present.

Enumerator

UCT_MD_MEM_ATTR_FIELD_MEM_TYPE	Indicate if memory type is populated. E.g. CPU/GPU
UCT_MD_MEM_ATTR_FIELD_SYS_DEV	Indicate if details of system device backing the pointer are populated. For example: GPU device, NUMA domain, etc.
UCT_MD_MEM_ATTR_FIELD_BASE_ADDRESS	Request base address of the allocation to which the buffer belongs.
UCT_MD_MEM_ATTR_FIELD_ALLOC_LENGTH	Request the whole length of the allocation to which the buffer belongs.
UCT_MD_MEM_ATTR_FIELD_DMABUF_FD	Request a cross-device dmabuf file descriptor that represents a memory region, and can be used to register the region with another memory domain.
UCT_MD_MEM_ATTR_FIELD_DMABUF_OFFSET	Request the offset of the provided virtual address relative to the beginning of its backing dmabuf region.

6.13.4.6 uct_mem_alloc_params_field_t

`enum uct_mem_alloc_params_field_t`

The enumeration allows specifying which fields in uct_mem_alloc_params_t are present.

Enumerator

UCT_MEM_ALLOC_PARAM_FIELD_FLAGS	Enables uct_mem_alloc_params_t::flags

Enumerator

UCT_MEM_ALLOC_PARAM_FIELD_ADDRESS	Enables uct_mem_alloc_params_t::address
UCT_MEM_ALLOC_PARAM_FIELD_MEM_TYPE	Enables uct_mem_alloc_params_t::mem_type
UCT_MEM_ALLOC_PARAM_FIELD_MDS	Enables uct_mem_alloc_params_t::mds
UCT_MEM_ALLOC_PARAM_FIELD_NAME	Enables uct_mem_alloc_params_t::name

6.13.5 Function Documentation

6.13.5.1 uct_md_mem_query()

```
ucs_status_t uct_md_mem_query (
            uct_md_h md,
            const void * address,
            size_t length,
            uct_md_mem_attr_t * mem_attr )
```

Return attributes such as memory type, base address, allocation length, and system device for the given pointer of specific length.

Parameters

in	*md*	Memory domain to run the query on. This function returns an error if the md does not recognize the pointer.
in	*address*	The address of the pointer. Must be non-NULL else UCS_ERR_INVALID_PARAM error is returned.
in	*length*	Length of the memory region to examine. Must be nonzero else UCS_ERR_INVALID_PARAM error is returned.
in,out	*mem_attr*	If successful, filled with ptr attributes.

Returns

UCS_OK if at least one attribute is successfully queried otherwise an error code as defined by ucs_status_t is returned.

6.13.5.2 uct_md_query()

```
ucs_status_t uct_md_query (
            uct_md_h md,
            uct_md_attr_t * md_attr )
```

Parameters

in	*md*	Memory domain to query.
out	*md_attr*	Filled with memory domain attributes.

Examples:

uct_hello_world.c.

6.13.5.3 uct_md_mem_advise()

```
ucs_status_t uct_md_mem_advise (
             uct_md_h md,
             uct_mem_h memh,
             void * addr,
             size_t length,
             uct_mem_advice_t advice )
```

This routine advises the UCT about how to handle memory range beginning at address and size of length bytes. This call does not influence the semantics of the application, but may influence its performance. The advice may be ignored.

Parameters

in	*md*	Memory domain memory was allocated or registered on.
in	*memh*	Memory handle, as returned from uct_mem_alloc
in	*addr*	Memory base address. Memory range must belong to the *memh*
in	*length*	Length of memory to advise. Must be >0.
in	*advice*	Memory use advice as defined in the uct_mem_advice_t list

6.13.5.4 uct_md_mem_reg()

```
ucs_status_t uct_md_mem_reg (
             uct_md_h md,
             void * address,
             size_t length,
             unsigned flags,
             uct_mem_h * memh_p )
```

Register memory on the memory domain. In order to use this function, MD must support UCT_MD_FLAG_REG flag.

Parameters

in	*md*	Memory domain to register memory on.
in	*address*	Memory to register.
in	*length*	Size of memory to register. Must be >0.
in	*flags*	Memory allocation flags, see uct_md_mem_flags.
out	*memh↩_p*	Filled with handle for allocated region.

Examples:

uct_hello_world.c.

6.13.5.5 uct_md_mem_dereg()

```
ucs_status_t uct_md_mem_dereg (
            uct_md_h md,
            uct_mem_h memh )
```

Parameters

in	*md*	Memory domain which was used to register the memory.
in	*memh*	Local access key to memory region.

Examples:

uct_hello_world.c.

6.13.5.6 uct_md_detect_memory_type()

```
ucs_status_t uct_md_detect_memory_type (
            uct_md_h md,
            const void * addr,
            size_t length,
            ucs_memory_type_t * mem_type_p )
```

Parameters

in	*md*	Memory domain to detect memory type
in	*addr*	Memory address to detect.
in	*length*	Size of memory
out	*mem_type↵_p*	Filled with memory type of the address range if function succeeds

Returns

UCS_OK If memory type is successfully detected UCS_ERR_INVALID_ADDR If failed to detect memory type

6.13.5.7 uct_mem_alloc()

```
ucs_status_t uct_mem_alloc (
            size_t length,
            const uct_alloc_method_t * methods,
            unsigned num_methods,
            const uct_mem_alloc_params_t * params,
            uct_allocated_memory_t * mem )
```

Allocate potentially registered memory.

Parameters

in	*length*	The minimal size to allocate. The actual size may be larger, for example because of alignment restrictions. Must be >0.

Parameters

in	*methods*	Array of memory allocation methods to attempt. Each of the provided allocation methods will be tried in array order, to perform the allocation, until one succeeds. Whenever the MD method is encountered, each of the provided MDs will be tried in array order, to allocate the memory, until one succeeds, or they are exhausted. In this case the next allocation method from the initial list will be attempted.
in	*num_methods*	Length of 'methods' array.
in	*params*	Memory allocation characteristics, see uct_mem_alloc_params_t.
out	*mem*	In case of success, filled with information about the allocated memory. uct_allocated_memory_t

6.13.5.8 uct_mem_free()

```
ucs_status_t uct_mem_free (
            const uct_allocated_memory_t * mem )
```

Release the memory allocated by uct_mem_alloc.

Parameters

in	*mem*	Description of allocated memory, as returned from uct_mem_alloc.

6.13.5.9 uct_md_config_read()

```
ucs_status_t uct_md_config_read (
            uct_component_h component,
            const char * env_prefix,
            const char * filename,
            uct_md_config_t ** config_p )
```

Parameters

in	*component*	Read the configuration of this component.
in	*env_prefix*	If non-NULL, search for environment variables starting with this UCT_<prefix>_. Otherwise, search for environment variables starting with just UCT_.
in	*filename*	If non-NULL, read configuration from this file. If the file does not exist, it will be ignored.
out	*config_p*	Filled with a pointer to the configuration.

Returns

Error code.

Examples:

uct_hello_world.c.

6.13.5.10 uct_md_is_sockaddr_accessible()

```
int uct_md_is_sockaddr_accessible (
             uct_md_h md,
             const ucs_sock_addr_t * sockaddr,
             uct_sockaddr_accessibility_t mode )
```

This function checks if a remote sock address can be accessed from a local memory domain. Accessibility can be checked in local or remote mode.

Parameters

in	*md*	Memory domain to check accessibility from. This memory domain must support the UCT_MD_FLAG_SOCKADDR flag.
in	*sockaddr*	Socket address to check accessibility to.
in	*mode*	Mode for checking accessibility, as defined in uct_sockaddr_accessibility_t. Indicates if accessibility is tested on the server side - for binding to the given sockaddr, or on the client side - for connecting to the given remote peer's sockaddr.

Returns

Nonzero if accessible, 0 if inaccessible.

6.13.5.11 uct_md_mkey_pack()

```
ucs_status_t uct_md_mkey_pack (
             uct_md_h md,
             uct_mem_h memh,
             void * rkey_buffer )
```

Parameters

in	*md*	Handle to memory domain.
in	*memh*	Local key, whose remote key should be packed.
out	*rkey_buffer*	Filled with packed remote key.

Returns

Error code.

6.13.5.12 uct_rkey_unpack()

```
ucs_status_t uct_rkey_unpack (
             uct_component_h component,
             const void * rkey_buffer,
             uct_rkey_bundle_t * rkey_ob )
```

Parameters

in	*component*	Component on which to unpack the remote key.
in	*rkey_buffer*	Packed remote key buffer.
out	*rkey_ob*	Filled with the unpacked remote key and its type.

Note

The remote key must be unpacked with the same component that was used to pack it. For example, if a remote device address on the remote memory domain which was used to pack the key is reachable by a transport on a local component, then that component is eligible to unpack the key. If the remote key buffer cannot be unpacked with the given component, UCS_ERR_INVALID_PARAM will be returned.

Returns

Error code.

6.13.5.13 uct_rkey_ptr()

```
ucs_status_t uct_rkey_ptr (
            uct_component_h component,
            uct_rkey_bundle_t * rkey_ob,
            uint64_t remote_addr,
            void ** addr_p )
```

This routine returns a local pointer to the remote memory described by the rkey bundle. The *component* must support UCT_COMPONENT_FLAG_RKEY_PTR flag.

Parameters

in	*component*	Component on which to obtain the pointer to the remote key.
in	*rkey_ob*	A remote key bundle as returned by the uct_rkey_unpack function.
in	*remote_addr*	A remote address within the memory area described by the rkey_ob.
out	*addr_p*	A pointer that can be used for direct access to the remote memory.

Note

The component used to obtain a local pointer to the remote memory must be the same component that was used to pack the remote key. See notes section for uct_rkey_unpack.

Returns

Error code if the remote memory cannot be accessed directly or the remote address is not valid.

6.13.5.14 uct_rkey_release()

```
ucs_status_t uct_rkey_release (
            uct_component_h component,
            const uct_rkey_bundle_t * rkey_ob )
```

Parameters

in	*component*	Component which was used to unpack the remote key.
in	*rkey_ob*	Remote key to release.

6.14 UCT Active messages

Typedefs

- typedef ucs_status_t(∗ uct_am_callback_t) (void ∗arg, void ∗data, size_t length, unsigned flags)

  Callback to process incoming active message.
- typedef void(∗ uct_am_tracer_t) (void ∗arg, uct_am_trace_type_t type, uint8_t id, const void ∗data, size_t length, char ∗buffer, size_t max)

  Callback to trace active messages.

Enumerations

- enum uct_msg_flags { UCT_SEND_FLAG_SIGNALED = UCS_BIT(0), UCT_SEND_FLAG_PEER_CHECK = UCS_BIT(1) }

  Flags for active message send operation.
- enum uct_am_trace_type {
  UCT_AM_TRACE_TYPE_SEND, UCT_AM_TRACE_TYPE_RECV, UCT_AM_TRACE_TYPE_SEND_DROP,
  UCT_AM_TRACE_TYPE_RECV_DROP,
  UCT_AM_TRACE_TYPE_LAST }

  Trace types for active message tracer.

Functions

- ucs_status_t uct_iface_set_am_handler (uct_iface_h iface, uint8_t id, uct_am_callback_t cb, void ∗arg, uint32_t flags)

  Set active message handler for the interface.
- ucs_status_t uct_iface_set_am_tracer (uct_iface_h iface, uct_am_tracer_t tracer, void ∗arg)

  Set active message tracer for the interface.
- void uct_iface_release_desc (void ∗desc)

  Release AM descriptor.
- ucs_status_t uct_ep_am_short (uct_ep_h ep, uint8_t id, uint64_t header, const void ∗payload, unsigned length)
- ucs_status_t uct_ep_am_short_iov (uct_ep_h ep, uint8_t id, const uct_iov_t ∗iov, size_t iovcnt)

  Short io-vector send operation.
- ssize_t uct_ep_am_bcopy (uct_ep_h ep, uint8_t id, uct_pack_callback_t pack_cb, void ∗arg, unsigned flags)
- ucs_status_t uct_ep_am_zcopy (uct_ep_h ep, uint8_t id, const void ∗header, unsigned header_length, const uct_iov_t ∗iov, size_t iovcnt, unsigned flags, uct_completion_t ∗comp)

  Send active message while avoiding local memory copy.

6.14.1 Detailed Description

Defines active message functions.

6.14.2 Typedef Documentation

6.14.2.1 uct_am_callback_t

```
typedef ucs_status_t(* uct_am_callback_t) (void *arg, void *data, size_t length, unsigned flags)
```

When the callback is called, *flags* indicates how *data* should be handled. If *flags* contain UCT_CB_PARAM_FLAG_DESC value, it means *data* is part of a descriptor which must be released later by uct_iface_release_desc by the user if the callback returns UCS_INPROGRESS.

Parameters

in	*arg*	User-defined argument.
in	*data*	Points to the received data. This may be a part of a descriptor which may be released later.
in	*length*	Length of data.
in	*flags*	Mask with uct_cb_param_flags

Note

This callback could be set and released by uct_iface_set_am_handler function.

Return values

UCS_OK	- descriptor was consumed, and can be released by the caller.
UCS_INPROGRESS	- descriptor is owned by the callee, and would be released later. Supported only if *flags* contain UCT_CB_PARAM_FLAG_DESC value. Otherwise, this is an error.

6.14.2.2 uct_am_tracer_t

```
typedef void(* uct_am_tracer_t) (void *arg, uct_am_trace_type_t type, uint8_t id, const void
*data, size_t length, char *buffer, size_t max)
```

Writes a string which represents active message contents into 'buffer'.

Parameters

in	*arg*	User-defined argument.
in	*type*	Message type.
in	*id*	Active message id.
in	*data*	Points to the received data.
in	*length*	Length of data.
out	*buffer*	Filled with a debug information string.
in	*max*	Maximal length of the string.

6.14.3 Enumeration Type Documentation

6.14.3.1 uct_msg_flags

```
enum uct_msg_flags
```

Enumerator

UCT_SEND_FLAG_SIGNALED	Trigger UCT_EVENT_RECV_SIG event on remote side. Make best effort attempt to avoid triggering UCT_EVENT_RECV event. Ignored if not supported by interface.
UCT_SEND_FLAG_PEER_CHECK	Forces checking connectivity to a peer. If the connection is not alive, an error callback will be invoked. If the flag is not set, there is no guarantee that a connectivity error could be detected.

6.14.3.2 uct_am_trace_type

```
enum uct_am_trace_type
```

Enumerator

UCT_AM_TRACE_TYPE_SEND	
UCT_AM_TRACE_TYPE_RECV	
UCT_AM_TRACE_TYPE_SEND_DROP	
UCT_AM_TRACE_TYPE_RECV_DROP	
UCT_AM_TRACE_TYPE_LAST	

6.14.4 Function Documentation

6.14.4.1 uct_iface_set_am_handler()

```
ucs_status_t uct_iface_set_am_handler (
             uct_iface_h iface,
             uint8_t id,
             uct_am_callback_t cb,
             void * arg,
             uint32_t flags )
```

Only one handler can be set of each active message ID, and setting a handler replaces the previous value. If cb == NULL, the current handler is removed.

Parameters

in	*iface*	Interface to set the active message handler for.
in	*id*	Active message id. Must be 0..UCT_AM_ID_MAX-1.
in	*cb*	Active message callback. NULL to clear.
in	*arg*	Active message argument.
in	*flags*	Required callback flags

Returns

error code if the interface does not support active messages or requested callback flags

Examples:

uct_hello_world.c.

6.14.4.2 uct_iface_set_am_tracer()

```
ucs_status_t uct_iface_set_am_tracer (
             uct_iface_h iface,
             uct_am_tracer_t tracer,
             void * arg )
```

Sets a function which dumps active message debug information to a buffer, which is printed every time an active message is sent or received, when data tracing is on. Without the tracer, only transport-level information is printed.

Parameters

in	*iface*	Interface to set the active message tracer for.
in	*tracer*	Active message tracer. NULL to clear.
in	*arg*	Tracer custom argument.

6.14.4.3 uct_iface_release_desc()

```
void uct_iface_release_desc (
             void * desc )
```

Release active message descriptor *desc*, which was passed to the active message callback, and owned by the callee.

Parameters

in	*desc*	Descriptor to release.

Examples:

uct_hello_world.c.

6.14.4.4 uct_ep_am_short()

```
ucs_status_t uct_ep_am_short (
             uct_ep_h ep,
             uint8_t id,
             uint64_t header,
             const void * payload,
             unsigned length )
```

Examples:

uct_hello_world.c.

6.14.4.5 uct_ep_am_short_iov()

```
ucs_status_t uct_ep_am_short_iov (
             uct_ep_h ep,
             uint8_t id,
             const uct_iov_t * iov,
             size_t iovcnt )
```

This routine sends a message using short protocol. The input data in *iov* array of uct_iov_t structures is sent to remote side to contiguous buffer keeping the order of the data in the array.

Parameters

in	*ep*	Destination endpoint handle.
in	*id*	Active message id. Must be in range 0..UCT_AM_ID_MAX-1.
in	*iov*	Points to an array of uct_iov_t structures. The *iov* pointer must be a valid address of an array of uct_iov_t structures. A particular structure pointer must be a valid address. A NULL terminated array is not required. *stride* and *count* fields in uct_iov_t structure are ignored in current implementation. The total size of the data buffers in the array is limited by uct_iface_attr::cap::am::max_short.
in	*iovcnt*	Size of the *iov* data uct_iov_t structures array. If *iovcnt* is zero, the data is considered empty. *iovcnt* is limited by uct_iface_attr::cap::am::max_iov.

Returns

UCS_OK Operation completed successfully.
UCS_ERR_NO_RESOURCE Could not start the operation due to lack of send resources.
otherwise Error code.

6.14.4.6 uct_ep_am_bcopy()

```
ssize_t uct_ep_am_bcopy (
             uct_ep_h ep,
             uint8_t id,
             uct_pack_callback_t pack_cb,
             void * arg,
             unsigned flags )
```

Examples:

uct_hello_world.c.

6.14.4.7 uct_ep_am_zcopy()

```
ucs_status_t uct_ep_am_zcopy (
             uct_ep_h ep,
             uint8_t id,
             const void * header,
             unsigned header_length,
             const uct_iov_t * iov,
             size_t iovcnt,
             unsigned flags,
             uct_completion_t * comp )
```

The input data in *iov* array of uct_iov_t structures sent to remote side ("gather output"). Buffers in *iov* are processed in array order. This means that the function complete iov[0] before proceeding to iov[1], and so on.

Parameters

in	*ep*	Destination endpoint handle.
in	*id*	Active message id. Must be in range 0..UCT_AM_ID_MAX-1.
in	*header*	Active message header.
in	*header_length*	Active message header length in bytes.
in	*iov*	Points to an array of uct_iov_t structures. The *iov* pointer must be a valid address of an array of uct_iov_t structures. A particular structure pointer must be a valid address. A NULL terminated array is not required.
in	*iovcnt*	Size of the *iov* data uct_iov_t structures array. If *iovcnt* is zero, the data is considered empty. *iovcnt* is limited by uct_iface_attr::cap::am::max_iov.
in	*flags*	Active message flags, see uct_msg_flags.
in	*comp*	Completion handle as defined by uct_completion_t.

Returns

UCS_OK Operation completed successfully.
UCS_INPROGRESS Some communication operations are still in progress. If non-NULL *comp* is provided, it will be updated upon completion of these operations.
UCS_ERR_NO_RESOURCE Could not start the operation due to lack of send resources.

Note

If the operation returns *UCS_INPROGRESS*, the memory buffers pointed to by *iov* array must not be modified until the operation is completed by *comp*. *header* can be released or changed.

Examples:

uct_hello_world.c.

6.15 UCT Remote memory access operations

Functions

- ucs_status_t uct_ep_put_short (uct_ep_h ep, const void ∗buffer, unsigned length, uint64_t remote_addr, uct_rkey_t rkey)
- ssize_t uct_ep_put_bcopy (uct_ep_h ep, uct_pack_callback_t pack_cb, void ∗arg, uint64_t remote_addr, uct_rkey_t rkey)
- ucs_status_t uct_ep_put_zcopy (uct_ep_h ep, const uct_iov_t ∗iov, size_t iovcnt, uint64_t remote_addr, uct_rkey_t rkey, uct_completion_t ∗comp)

    Write data to remote memory while avoiding local memory copy.
- ucs_status_t uct_ep_get_short (uct_ep_h ep, void ∗buffer, unsigned length, uint64_t remote_addr, uct_rkey_t rkey)
- ucs_status_t uct_ep_get_bcopy (uct_ep_h ep, uct_unpack_callback_t unpack_cb, void ∗arg, size_t length, uint64_t remote_addr, uct_rkey_t rkey, uct_completion_t ∗comp)
- ucs_status_t uct_ep_get_zcopy (uct_ep_h ep, const uct_iov_t ∗iov, size_t iovcnt, uint64_t remote_addr, uct_rkey_t rkey, uct_completion_t ∗comp)

    Read data from remote memory while avoiding local memory copy.

6.15.1 Detailed Description

Defines remote memory access operations.

6.15.2 Function Documentation

6.15.2.1 uct_ep_put_short()

```
ucs_status_t uct_ep_put_short (
              uct_ep_h ep,
              const void * buffer,
              unsigned length,
              uint64_t remote_addr,
              uct_rkey_t rkey )
```

6.15.2.2 uct_ep_put_bcopy()

```
ssize_t uct_ep_put_bcopy (
              uct_ep_h ep,
              uct_pack_callback_t pack_cb,
              void * arg,
              uint64_t remote_addr,
              uct_rkey_t rkey )
```

6.15.2.3 uct_ep_put_zcopy()

```
ucs_status_t uct_ep_put_zcopy (
              uct_ep_h ep,
              const uct_iov_t * iov,
              size_t iovcnt,
              uint64_t remote_addr,
              uct_rkey_t rkey,
              uct_completion_t * comp )
```

The input data in *iov* array of uct_iov_t structures sent to remote address ("gather output"). Buffers in *iov* are processed in array order. This means that the function complete iov[0] before proceeding to iov[1], and so on.

Parameters

in	*ep*	Destination endpoint handle.
in	*iov*	Points to an array of uct_iov_t structures. The *iov* pointer must be a valid address of an array of uct_iov_t structures. A particular structure pointer must be a valid address. A NULL terminated array is not required.
in	*iovcnt*	Size of the *iov* data uct_iov_t structures array. If *iovcnt* is zero, the data is considered empty. *iovcnt* is limited by uct_iface_attr::cap::put::max_iov.
in	*remote_addr*	Remote address to place the *iov* data.
in	*rkey*	Remote key descriptor provided by uct_rkey_unpack
in	*comp*	Completion handle as defined by uct_completion_t.

Returns

UCS_INPROGRESS Some communication operations are still in progress. If non-NULL *comp* is provided, it will be updated upon completion of these operations.

6.15.2.4 uct_ep_get_short()

```
ucs_status_t uct_ep_get_short (
            uct_ep_h ep,
            void * buffer,
            unsigned length,
            uint64_t remote_addr,
            uct_rkey_t rkey )
```

6.15.2.5 uct_ep_get_bcopy()

```
ucs_status_t uct_ep_get_bcopy (
            uct_ep_h ep,
            uct_unpack_callback_t unpack_cb,
            void * arg,
            size_t length,
            uint64_t remote_addr,
            uct_rkey_t rkey,
            uct_completion_t * comp )
```

6.15.2.6 uct_ep_get_zcopy()

```
ucs_status_t uct_ep_get_zcopy (
            uct_ep_h ep,
            const uct_iov_t * iov,
            size_t iovcnt,
            uint64_t remote_addr,
            uct_rkey_t rkey,
            uct_completion_t * comp )
```

The output data in *iov* array of uct_iov_t structures received from remote address ("scatter input"). Buffers in *iov* are processed in array order. This means that the function complete iov[0] before proceeding to iov[1], and so on.

Parameters

in	*ep*	Destination endpoint handle.
in	*iov*	Points to an array of uct_iov_t structures. The *iov* pointer must be a valid address of an array of uct_iov_t structures. A particular structure pointer must be a valid address. A NULL terminated array is not required.
in	*iovcnt*	Size of the *iov* data uct_iov_t structures array. If *iovcnt* is zero, the data is considered empty. *iovcnt* is limited by uct_iface_attr::cap::get::max_iov.
in	*remote_addr*	Remote address of the data placed to the *iov*.
in	*rkey*	Remote key descriptor provided by uct_rkey_unpack
in	*comp*	Completion handle as defined by uct_completion_t.

Returns

UCS_INPROGRESS Some communication operations are still in progress. If non-NULL *comp* is provided, it will be updated upon completion of these operations.

6.16 UCT Atomic operations

Functions

- ucs_status_t uct_ep_atomic_cswap64 (uct_ep_h ep, uint64_t compare, uint64_t swap, uint64_t remote_addr, uct_rkey_t rkey, uint64_t ∗result, uct_completion_t ∗comp)
- ucs_status_t uct_ep_atomic_cswap32 (uct_ep_h ep, uint32_t compare, uint32_t swap, uint64_t remote_addr, uct_rkey_t rkey, uint32_t ∗result, uct_completion_t ∗comp)
- ucs_status_t uct_ep_atomic32_post (uct_ep_h ep, uct_atomic_op_t opcode, uint32_t value, uint64_↩ t remote_addr, uct_rkey_t rkey)
- ucs_status_t uct_ep_atomic64_post (uct_ep_h ep, uct_atomic_op_t opcode, uint64_t value, uint64_↩ t remote_addr, uct_rkey_t rkey)
- ucs_status_t uct_ep_atomic32_fetch (uct_ep_h ep, uct_atomic_op_t opcode, uint32_t value, uint32_t ∗result, uint64_t remote_addr, uct_rkey_t rkey, uct_completion_t ∗comp)
- ucs_status_t uct_ep_atomic64_fetch (uct_ep_h ep, uct_atomic_op_t opcode, uint64_t value, uint64_t ∗result, uint64_t remote_addr, uct_rkey_t rkey, uct_completion_t ∗comp)

6.16.1 Detailed Description

Defines atomic operations.

6.16.2 Function Documentation

6.16.2.1 uct_ep_atomic_cswap64()

```
ucs_status_t uct_ep_atomic_cswap64 (
             uct_ep_h ep,
             uint64_t compare,
             uint64_t swap,
             uint64_t remote_addr,
             uct_rkey_t rkey,
             uint64_t * result,
             uct_completion_t * comp )
```

6.16.2.2 uct_ep_atomic_cswap32()

```
ucs_status_t uct_ep_atomic_cswap32 (
             uct_ep_h ep,
             uint32_t compare,
             uint32_t swap,
             uint64_t remote_addr,
             uct_rkey_t rkey,
             uint32_t * result,
             uct_completion_t * comp )
```

6.16.2.3 uct_ep_atomic32_post()

```
ucs_status_t uct_ep_atomic32_post (
             uct_ep_h ep,
             uct_atomic_op_t opcode,
             uint32_t value,
             uint64_t remote_addr,
             uct_rkey_t rkey )
```

6.16.2.4 uct_ep_atomic64_post()

```
ucs_status_t uct_ep_atomic64_post (
              uct_ep_h ep,
              uct_atomic_op_t opcode,
              uint64_t value,
              uint64_t remote_addr,
              uct_rkey_t rkey )
```

6.16.2.5 uct_ep_atomic32_fetch()

```
ucs_status_t uct_ep_atomic32_fetch (
              uct_ep_h ep,
              uct_atomic_op_t opcode,
              uint32_t value,
              uint32_t * result,
              uint64_t remote_addr,
              uct_rkey_t rkey,
              uct_completion_t * comp )
```

6.16.2.6 uct_ep_atomic64_fetch()

```
ucs_status_t uct_ep_atomic64_fetch (
              uct_ep_h ep,
              uct_atomic_op_t opcode,
              uint64_t value,
              uint64_t * result,
              uint64_t remote_addr,
              uct_rkey_t rkey,
              uct_completion_t * comp )
```

6.17 UCT Tag matching operations

Data Structures

- struct uct_tag_context

  Posted tag context.

Typedefs

- typedef ucs_status_t(∗ uct_tag_unexp_eager_cb_t) (void ∗arg, void ∗data, size_t length, unsigned flags, uct_tag_t stag, uint64_t imm, void ∗∗context)

  Callback to process unexpected eager tagged message.
- typedef ucs_status_t(∗ uct_tag_unexp_rndv_cb_t) (void ∗arg, unsigned flags, uint64_t stag, const void ∗header, unsigned header_length, uint64_t remote_addr, size_t length, const void ∗rkey_buf)

  Callback to process unexpected rendezvous tagged message.

Functions

- ucs_status_t uct_ep_tag_eager_short (uct_ep_h ep, uct_tag_t tag, const void ∗data, size_t length)

  Short eager tagged-send operation.
- ssize_t uct_ep_tag_eager_bcopy (uct_ep_h ep, uct_tag_t tag, uint64_t imm, uct_pack_callback_t pack_cb, void ∗arg, unsigned flags)

  Bcopy eager tagged-send operation.
- ucs_status_t uct_ep_tag_eager_zcopy (uct_ep_h ep, uct_tag_t tag, uint64_t imm, const uct_iov_t ∗iov, size↩ _t iovcnt, unsigned flags, uct_completion_t ∗comp)

  Zcopy eager tagged-send operation.
- ucs_status_ptr_t uct_ep_tag_rndv_zcopy (uct_ep_h ep, uct_tag_t tag, const void ∗header, unsigned header_length, const uct_iov_t ∗iov, size_t iovcnt, unsigned flags, uct_completion_t ∗comp)

  Rendezvous tagged-send operation.
- ucs_status_t uct_ep_tag_rndv_cancel (uct_ep_h ep, void ∗op)

  Cancel outstanding rendezvous operation.
- ucs_status_t uct_ep_tag_rndv_request (uct_ep_h ep, uct_tag_t tag, const void ∗header, unsigned header↩ _length, unsigned flags)

  Send software rendezvous request.
- ucs_status_t uct_iface_tag_recv_zcopy (uct_iface_h iface, uct_tag_t tag, uct_tag_t tag_mask, const uct_iov_t ∗iov, size_t iovcnt, uct_tag_context_t ∗ctx)

  Post a tag to a transport interface.
- ucs_status_t uct_iface_tag_recv_cancel (uct_iface_h iface, uct_tag_context_t ∗ctx, int force)

  Cancel a posted tag.

6.17.1 Detailed Description

Defines tag matching operations.

6.17.2 Typedef Documentation

6.17.2.1 uct_tag_unexp_eager_cb_t

```
typedef ucs_status_t(* uct_tag_unexp_eager_cb_t) (void *arg, void *data, size_t length, unsigned
flags, uct_tag_t stag, uint64_t imm, void **context)
```

This callback is invoked when tagged message sent by eager protocol has arrived and no corresponding tag has been posted.

Note

The callback is always invoked from the context (thread, process) that called *uct_iface_progress()*. It is allowed to call other communication routines from the callback.

Parameters

in	*arg*	User-defined argument
in	*data*	Points to the received unexpected data.
in	*length*	Length of data.
in	*flags*	Mask with uct_cb_param_flags flags. If it contains UCT_CB_PARAM_FLAG_DESC value, this means *data* is part of a descriptor which must be released later using uct_iface_release_desc by the user if the callback returns UCS_INPROGRESS.
in	*stag*	Tag from sender.
in	*imm*	Immediate data from sender.
in,out	*context*	Storage for a per-message user-defined context. In this context, the message is defined by the sender side as a single call to uct_ep_tag_eager_short/bcopy/zcopy. On the transport level the message can be fragmented and delivered to the target over multiple fragments. The fragments will preserve the original order of the message. Each fragment will result in invocation of the above callback. The user can use UCT_CB_PARAM_FLAG_FIRST to identify the first fragment, allocate the context object and use the context as a token that is set by the user and passed to subsequent callbacks of the same message. The user is responsible for allocation and release of the context.

Note

No need to allocate the context in the case of a single fragment message (i.e. *flags* contains UCT_CB_PARAM_FLAG_FIRST, but does not contain UCT_CB_PARAM_FLAG_MORE).

Return values

UCS_OK	- data descriptor was consumed, and can be released by the caller.
UCS_INPROGRESS	- data descriptor is owned by the callee, and will be released later.

6.17.2.2 uct_tag_unexp_rndv_cb_t

```
typedef ucs_status_t(* uct_tag_unexp_rndv_cb_t) (void *arg, unsigned flags, uint64_t stag,
const void *header, unsigned header_length, uint64_t remote_addr, size_t length, const void
*rkey_buf)
```

This callback is invoked when rendezvous send notification has arrived and no corresponding tag has been posted.

Note

The callback is always invoked from the context (thread, process) that called *uct_iface_progress()*.
It is allowed to call other communication routines from the callback.

Parameters

in	*arg*	User-defined argument
in	*flags*	Mask with uct_cb_param_flags
in	*stag*	Tag from sender.
in	*header*	User defined header.
in	*header_length*	User defined header length in bytes.
in	*remote_addr*	Sender's buffer virtual address.
in	*length*	Sender's buffer length.
in	*rkey_buf*	Sender's buffer packed remote key. It can be passed to uct_rkey_unpack() to create uct_rkey_t.

Warning

If the user became the owner of the *desc* (by returning UCS_INPROGRESS) the descriptor must be released later by uct_iface_release_desc by the user.

Return values

UCS_OK	- descriptor was consumed, and can be released by the caller.
UCS_INPROGRESS	- descriptor is owned by the callee, and would be released later.

6.17.3 Function Documentation

6.17.3.1 uct_ep_tag_eager_short()

```
ucs_status_t uct_ep_tag_eager_short (
             uct_ep_h ep,
             uct_tag_t tag,
             const void * data,
             size_t length )
```

This routine sends a message using short eager protocol. Eager protocol means that the whole data is sent to the peer immediately without any preceding notification. The data is provided as buffer and its length,and must not be larger than the corresponding *max_short* value in uct_iface_attr. The immediate value delivered to the receiver is implicitly equal to 0. If it's required to pass nonzero imm value, uct_ep_tag_eager_bcopy should be used.

Parameters

in	*ep*	Destination endpoint handle.
in	*tag*	Tag to use for the eager message.
in	*data*	Data to send.
in	*length*	Data length.

Returns

UCS_OK - operation completed successfully.
UCS_ERR_NO_RESOURCE - could not start the operation due to lack of send resources.

6.17.3.2 uct_ep_tag_eager_bcopy()

```
ssize_t uct_ep_tag_eager_bcopy (
            uct_ep_h ep,
            uct_tag_t tag,
            uint64_t imm,
            uct_pack_callback_t pack_cb,
            void * arg,
            unsigned flags )
```

This routine sends a message using bcopy eager protocol. Eager protocol means that the whole data is sent to the peer immediately without any preceding notification. Custom data callback is used to copy the data to the network buffers.

Note

The resulted data length must not be larger than the corresponding *max_bcopy* value in uct_iface_attr.

Parameters

in	*ep*	Destination endpoint handle.
in	*tag*	Tag to use for the eager message.
in	*imm*	Immediate value which will be available to the receiver.
in	*pack_cb*	User callback to pack the data.
in	*arg*	Custom argument to *pack_cb*.
in	*flags*	Tag message flags, see uct_msg_flags.

Returns

>=0 - The size of the data packed by *pack_cb*.
otherwise - Error code.

6.17.3.3 uct_ep_tag_eager_zcopy()

```
ucs_status_t uct_ep_tag_eager_zcopy (
            uct_ep_h ep,
            uct_tag_t tag,
            uint64_t imm,
            const uct_iov_t * iov,
            size_t iovcnt,
            unsigned flags,
            uct_completion_t * comp )
```

This routine sends a message using zcopy eager protocol. Eager protocol means that the whole data is sent to the peer immediately without any preceding notification. The input data (which has to be previously registered) in *iov* array of uct_iov_t structures sent to remote side ("gather output"). Buffers in *iov* are processed in array order, so the function complete *iov*[0] before proceeding to *iov*[1], and so on.

Note

The resulted data length must not be larger than the corresponding *max_zcopy* value in uct_iface_attr.

Parameters

in	*ep*	Destination endpoint handle.
in	*tag*	Tag to use for the eager message.
in	*imm*	Immediate value which will be available to the receiver.
in	*iov*	Points to an array of uct_iov_t structures. A particular structure pointer must be a valid address. A NULL terminated array is not required.
in	*iovcnt*	Size of the *iov* array. If *iovcnt* is zero, the data is considered empty. Note that *iovcnt* is limited by the corresponding *max_iov* value in uct_iface_attr.
in	*flags*	Tag message flags, see uct_msg_flags.
in	*comp*	Completion callback which will be called when the data is reliably received by the peer, and the buffer can be reused or invalidated.

Returns

UCS_OK - operation completed successfully.
UCS_ERR_NO_RESOURCE - could not start the operation due to lack of send resources.
UCS_INPROGRESS - operation started, and *comp* will be used to notify when it's completed.

6.17.3.4 uct_ep_tag_rndv_zcopy()

```
ucs_status_ptr_t uct_ep_tag_rndv_zcopy (
            uct_ep_h ep,
            uct_tag_t tag,
            const void * header,
            unsigned header_length,
            const uct_iov_t * iov,
            size_t iovcnt,
            unsigned flags,
            uct_completion_t * comp )
```

This routine sends a message using rendezvous protocol. Rendezvous protocol means that only a small notification is sent at first, and the data itself is transferred later (when there is a match) to avoid extra memory copy.

Note

The header will be available to the receiver in case of unexpected rendezvous operation only, i.e. the peer has not posted tag for this message yet (by means of uct_iface_tag_recv_zcopy), when it is arrived.

Parameters

in	*ep*	Destination endpoint handle.
in	*tag*	Tag to use for the eager message.
in	*header*	User defined header.
in	*header_length*	User defined header length in bytes. Note that it is limited by the corresponding *max_hdr* value in uct_iface_attr.
in	*iov*	Points to an array of uct_iov_t structures. A particular structure pointer must be valid address. A NULL terminated array is not required.
in	*iovcnt*	Size of the *iov* array. If *iovcnt* is zero, the data is considered empty. Note that *iovcnt* is limited by the corresponding *max_iov* value in uct_iface_attr.

Parameters

in	*flags*	Tag message flags, see uct_msg_flags.
in	*comp*	Completion callback which will be called when the data is reliably received by the peer, and the buffer can be reused or invalidated.

Returns

> >=0 - The operation is in progress and the return value is a handle which can be used to cancel the outstanding rendezvous operation.
> otherwise - Error code.

6.17.3.5 uct_ep_tag_rndv_cancel()

```
ucs_status_t uct_ep_tag_rndv_cancel (
             uct_ep_h ep,
             void * op )
```

This routine signals the underlying transport disregard the outstanding operation without calling completion callback provided in uct_ep_tag_rndv_zcopy.

Note

> The operation handle should be valid at the time the routine is invoked. I.e. it should be a handle of the real operation which is not completed yet.

Parameters

in	*ep*	Destination endpoint handle.
in	*op*	Rendezvous operation handle, as returned from uct_ep_tag_rndv_zcopy.

Returns

> UCS_OK - The operation has been canceled.

6.17.3.6 uct_ep_tag_rndv_request()

```
ucs_status_t uct_ep_tag_rndv_request (
             uct_ep_h ep,
             uct_tag_t tag,
             const void * header,
             unsigned header_length,
             unsigned flags )
```

This routine sends a rendezvous request only, which indicates that the data transfer should be completed in software.

Parameters

in	*ep*	Destination endpoint handle.
in	*tag*	Tag to use for matching.

Parameters

in	*header*	User defined header
in	*header_length*	User defined header length in bytes. Note that it is limited by the corresponding *max_hdr* value in uct_iface_attr.
in	*flags*	Tag message flags, see uct_msg_flags.

Returns

UCS_OK - operation completed successfully.
UCS_ERR_NO_RESOURCE - could not start the operation due to lack of send resources.

6.17.3.7 uct_iface_tag_recv_zcopy()

```
ucs_status_t uct_iface_tag_recv_zcopy (
             uct_iface_h iface,
             uct_tag_t tag,
             uct_tag_t tag_mask,
             const uct_iov_t * iov,
             size_t iovcnt,
             uct_tag_context_t * ctx )
```

This routine posts a tag to be matched on a transport interface. When a message with the corresponding tag arrives it is stored in the user buffer (described by *iov* and *iovcnt*) directly. The operation completion is reported using callbacks on the *ctx* structure.

Parameters

in	*iface*	Interface to post the tag on.
in	*tag*	Tag to expect.
in	*tag_mask*	Mask which specifies what bits of the tag to compare.
in	*iov*	Points to an array of uct_iov_t structures. The *iov* pointer must be a valid address of an array of uct_iov_t structures. A particular structure pointer must be a valid address. A NULL terminated array is not required.
in	*iovcnt*	Size of the *iov* data uct_iov_t structures array. If *iovcnt* is zero, the data is considered empty. *iovcnt* is limited by uct_iface_attr::cap::tag::max_iov.
in,out	*ctx*	Context associated with this particular tag, "priv" field in this structure is used to track the state internally.

Returns

UCS_OK - The tag is posted to the transport.
UCS_ERR_NO_RESOURCE - Could not start the operation due to lack of resources.
UCS_ERR_EXCEEDS_LIMIT - No more room for tags in the transport.

6.17.3.8 uct_iface_tag_recv_cancel()

```
ucs_status_t uct_iface_tag_recv_cancel (
             uct_iface_h iface,
             uct_tag_context_t * ctx,
             int force )
```

This routine cancels a tag, which was previously posted by uct_iface_tag_recv_zcopy. The tag would be either matched or canceled, in a bounded time, regardless of the peer actions. The original completion callback of the tag would be called with the status if *force* is not set.

Parameters

in	*iface*	Interface to cancel the tag on.
in	*ctx*	Tag context which was used for posting the tag. If force is 0, *ctx->completed_cb* will be called with either UCS_OK which means the tag was matched and data received despite the cancel request, or UCS_ERR_CANCELED which means the tag was successfully canceled before it was matched.
in	*force*	Whether to report completions to *ctx->completed_cb*. If nonzero, the cancel is assumed to be successful, and the callback is not called.

Returns

UCS_OK - The tag is canceled in the transport.

6.18 UCT client-server operations

Data Structures

- struct uct_ep_connect_params

  Parameters for connecting a UCT endpoint by uct_ep_connect. More...
- struct uct_cm_attr

  Connection manager attributes, capabilities and limitations. More...
- struct uct_listener_attr

  UCT listener attributes, capabilities and limitations. More...
- struct uct_listener_params

  Parameters for creating a listener object uct_listener_h by uct_listener_create. More...
- struct uct_cm_ep_priv_data_pack_args

  Arguments to the client-server private data pack callback. More...
- struct uct_cm_ep_resolve_args

  Arguments to the client-server resolved callback. More...
- struct uct_cm_remote_data

  Data received from the remote peer. More...
- struct uct_cm_listener_conn_request_args

  Arguments to the listener's connection request callback. More...
- struct uct_cm_ep_client_connect_args

  Arguments to the client's connect callback. More...
- struct uct_cm_ep_server_conn_notify_args

  Arguments to the server's notify callback. More...

Typedefs

- typedef struct uct_cm_ep_priv_data_pack_args uct_cm_ep_priv_data_pack_args_t

  Arguments to the client-server private data pack callback.
- typedef struct uct_cm_ep_resolve_args uct_cm_ep_resolve_args_t

  Arguments to the client-server resolved callback.
- typedef struct uct_cm_remote_data uct_cm_remote_data_t

  Data received from the remote peer.
- typedef struct uct_cm_listener_conn_request_args uct_cm_listener_conn_request_args_t

  Arguments to the listener's connection request callback.
- typedef struct uct_cm_ep_client_connect_args uct_cm_ep_client_connect_args_t

  Arguments to the client's connect callback.
- typedef struct uct_cm_ep_server_conn_notify_args uct_cm_ep_server_conn_notify_args_t

  Arguments to the server's notify callback.
- typedef void(∗ uct_sockaddr_conn_request_callback_t) (uct_iface_h iface, void ∗arg, uct_conn_request_h conn_request, const void ∗conn_priv_data, size_t length)

  Callback to process an incoming connection request on the server side.
- typedef void(∗ uct_cm_listener_conn_request_callback_t) (uct_listener_h listener, void ∗arg, const uct_cm_listener_conn_request_args_t ∗conn_req_args)

  Callback to process an incoming connection request on the server side listener in a connection manager.
- typedef void(∗ uct_cm_ep_server_conn_notify_callback_t) (uct_ep_h ep, void ∗arg, const uct_cm_ep_server_conn_notify_args_ ∗connect_args)

  Callback to process an incoming connection establishment acknowledgment on the server side listener, from the client, which indicates that the client side is connected. The callback also notifies the server side of a local error on a not-yet-connected endpoint.
- typedef void(∗ uct_cm_ep_client_connect_callback_t) (uct_ep_h ep, void ∗arg, const uct_cm_ep_client_connect_args_t ∗connect_args)

Callback to process an incoming connection response on the client side from the server or handle a local error on a not-yet-connected endpoint.

- typedef void(∗ uct_ep_disconnect_cb_t) (uct_ep_h ep, void ∗arg)

  Callback to handle the disconnection of the remote peer.
- typedef ssize_t(∗ uct_cm_ep_priv_data_pack_callback_t) (void ∗arg, const uct_cm_ep_priv_data_pack_args_t ∗pack_args, void ∗priv_data)

  Callback to fill the user's private data in a client-server flow.
- typedef ucs_status_t(∗ uct_cm_ep_resolve_callback_t) (void ∗user_data, const uct_cm_ep_resolve_args_t ∗resolve_args)

  Callback to notify that the client side endpoint is bound to a local device.

Enumerations

- enum uct_cm_attr_field { UCT_CM_ATTR_FIELD_MAX_CONN_PRIV = UCS_BIT(0) }

  UCT connection manager attributes field mask.
- enum uct_listener_attr_field { UCT_LISTENER_ATTR_FIELD_SOCKADDR = UCS_BIT(0) }

  UCT listener attributes field mask.
- enum uct_listener_params_field { UCT_LISTENER_PARAM_FIELD_BACKLOG = UCS_BIT(0), UCT_LISTENER_PARAM_FIE = UCS_BIT(1), UCT_LISTENER_PARAM_FIELD_USER_DATA = UCS_BIT(2) }

  UCT listener created by uct_listener_create parameters field mask.
- enum uct_ep_connect_params_field { UCT_EP_CONNECT_PARAM_FIELD_PRIVATE_DATA = UCS_B←↩IT(0), UCT_EP_CONNECT_PARAM_FIELD_PRIVATE_DATA_LENGTH = UCS_BIT(1) }

  UCT endpoint connected by uct_ep_connect parameters field mask.
- enum uct_cm_ep_priv_data_pack_args_field { UCT_CM_EP_PRIV_DATA_PACK_ARGS_FIELD_DEVICE_NAME = UCS_BIT(0) }

  Client-Server private data pack callback arguments field mask.
- enum uct_cm_ep_resolve_args_field { UCT_CM_EP_RESOLVE_ARGS_FIELD_DEV_NAME = UCS_B←↩IT(0), UCT_CM_EP_RESOLVE_ARGS_FIELD_STATUS = UCS_BIT(1) }

  Client-Server resolve callback arguments field mask.
- enum uct_cm_remote_data_field { UCT_CM_REMOTE_DATA_FIELD_DEV_ADDR = UCS_BIT(0), UCT_CM_REMOTE_DATA_FIELD_DEV_ADDR_LENGTH = UCS_BIT(1), UCT_CM_REMOTE_DATA_FIELD_CONN_PRIV_ = UCS_BIT(2), UCT_CM_REMOTE_DATA_FIELD_CONN_PRIV_DATA_LENGTH = UCS_BIT(3) }

  Remote data attributes field mask.
- enum uct_cm_listener_conn_request_args_field { UCT_CM_LISTENER_CONN_REQUEST_ARGS_FIELD_DEV_NAME = UCS_BIT(0), UCT_CM_LISTENER_CONN_REQUEST_ARGS_FIELD_CONN_REQUEST = UC←↩S_BIT(1), UCT_CM_LISTENER_CONN_REQUEST_ARGS_FIELD_REMOTE_DATA = UCS_BIT(2), UCT_CM_LISTENER_CONN_REQUEST_ARGS_FIELD_CLIENT_ADDR = UCS_BIT(3) }

  Listener's connection request callback arguments field mask.
- enum uct_cm_ep_client_connect_args_field { UCT_CM_EP_CLIENT_CONNECT_ARGS_FIELD_REMOTE_DATA = UCS_BIT(0), UCT_CM_EP_CLIENT_CONNECT_ARGS_FIELD_STATUS = UCS_BIT(1) }

  Field mask flags for client-side connection established callback.
- enum uct_cm_ep_server_conn_notify_args_field { UCT_CM_EP_SERVER_CONN_NOTIFY_ARGS_FIELD_STATUS = UCS_BIT(0) }

  Field mask flags for server-side connection established notification callback.

Functions

- ucs_status_t uct_iface_accept (uct_iface_h iface, uct_conn_request_h conn_request)

  Accept connection request.
- ucs_status_t uct_iface_reject (uct_iface_h iface, uct_conn_request_h conn_request)

  Reject connection request. Will invoke an error handler uct_error_handler_t on the remote transport interface, if set.
- ucs_status_t uct_ep_connect (uct_ep_h ep, const uct_ep_connect_params_t ∗params)

Connect a client side endpoint after it is bound to a local network device, i.e. uct_ep_params_t::cm_resolve_cb was invoked.

- ucs_status_t uct_ep_disconnect (uct_ep_h ep, unsigned flags)

  Initiate a disconnection of an endpoint connected to a sockaddr by a connection manager uct_cm_h.

- ucs_status_t uct_cm_open (uct_component_h component, uct_worker_h worker, const uct_cm_config_t ∗config, uct_cm_h ∗cm_p)

  Open a connection manager.

- void uct_cm_close (uct_cm_h cm)

  Close a connection manager.

- ucs_status_t uct_cm_query (uct_cm_h cm, uct_cm_attr_t ∗cm_attr)

  Get connection manager attributes.

- ucs_status_t uct_cm_config_read (uct_component_h component, const char ∗env_prefix, const char ∗filename, uct_cm_config_t ∗∗config_p)

  Read the configuration for a connection manager.

- ucs_status_t uct_cm_client_ep_conn_notify (uct_ep_h ep)

  Notify the server about client-side connection establishment.

- ucs_status_t uct_listener_create (uct_cm_h cm, const struct sockaddr ∗saddr, socklen_t socklen, const uct_listener_params_t ∗params, uct_listener_h ∗listener_p)

  Create a new transport listener object.

- void uct_listener_destroy (uct_listener_h listener)

  Destroy a transport listener.

- ucs_status_t uct_listener_reject (uct_listener_h listener, uct_conn_request_h conn_request)

  Reject a connection request.

- ucs_status_t uct_listener_query (uct_listener_h listener, uct_listener_attr_t ∗listener_attr)

  Get attributes specific to a particular listener.

6.18.1 Detailed Description

Defines client-server operations. The client-server API allows the connection establishment between an active side - a client, and its peer - the passive side - a server. The connection can be established through a UCT transport that supports listening and connecting via IP address and port (listening can also be on INADDR_ANY).

The following is a general overview of the operations on the server side:

Connecting: uct_cm_open Open a connection manager. uct_listener_create Create a listener on the CM and start listening on a given IP,port / INADDR_ANY. uct_cm_listener_conn_request_callback_t This callback is invoked by the UCT transport to handle an incoming connection request from a client. Accept or reject the client's connection request. uct_ep_create Connect to the client by creating an endpoint if the request is accepted. The server creates a new endpoint for every connection request that it accepts. uct_cm_ep_server_conn_notify_callback_t This callback is invoked by the UCT transport to handle the connection notification from the client.

Note

The private data which the server should send to the client can be either provided directly to uct_ep_create, or filled by uct_cm_ep_priv_data_pack_callback_t provided to uct_ep_create.
In order to reject a connection request, can either call uct_listener_reject or return failure status as defined by ucs_status_t from uct_cm_ep_priv_data_pack_callback_t.

Disconnecting: uct_ep_disconnect Disconnect the server's endpoint from the client. Can be called when initiating a disconnect or when receiving a disconnect notification from the remote side. uct_ep_disconnect_cb_t This callback is invoked by the UCT transport when the client side calls uct_ep_disconnect as well. uct_ep_destroy Destroy the endpoint connected to the remote peer. If this function is called before the endpoint was disconnected, the uct_ep_disconnect_cb_t will not be invoked.

Destroying the server's resources: uct_listener_destroy Destroy the listener object. uct_cm_close Close the connection manager.

The following is a general overview of the operations on the client side:

Connecting: uct_cm_open Open a connection manager. uct_ep_create Create an endpoint for establishing a connection to the server. uct_cm_ep_resolve_callback_t This callback is invoked on the client side of the connection manager, after the remote server address was resolved to the local device to be used for connection establishment. uct_ep_connect This function should be called on the client side, in order to send private data and resume connection establishment, following an address-resolved notification via uct_cm_ep_resolve_callback_t. uct_cm_ep_client_connect_callback_t This callback is invoked by the UCT transport to handle a connection response from the server. After invoking this callback, the UCT transport will finalize the client's connection to the server. uct_cm_client_ep_conn_notify After the client's connection establishment is completed, the client should call this function in which it sends a notification message to the server stating that it (the client) is connected. The notification message that is sent depends on the transport's implementation.

Disconnecting: uct_ep_disconnect Disconnect the client's endpoint from the server. Can be called when initiating a disconnect or when receiving a disconnect notification from the remote side. uct_ep_disconnect_cb_t This callback is invoked by the UCT transport when the server side calls uct_ep_disconnect as well. uct_ep_destroy Destroy the endpoint connected to the remote peer.

Destroying the client's resources: uct_cm_close Close the connection manager.

6.18.2 Data Structure Documentation

6.18.2.1 struct uct_ep_connect_params

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_ep_connect_params_field. Fields not specified by this mask will be ignored.
const void ∗	private_data	User's private data to be passed from client to server.
size_t	private_data_length	Length of uct_ep_connect_params::private_data, the maximal allowed value is indicated by the uct_cm_attr::max_conn_priv.

6.18.2.2 struct uct_cm_attr

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_cm_attr_field. Fields not specified by this mask will be ignored.
size_t	max_conn_priv	Max size of the connection manager's private data used for connection establishment with sockaddr.

6.18.2.3 struct uct_listener_attr

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_listener_attr_field. Fields not specified by this mask will be ignored.
struct sockaddr_storage	sockaddr	Sockaddr on which this listener is listening.

6.18.2.4 struct uct_listener_params

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_listener_params_field. Fields not specified by this mask will be ignored.
int	backlog	Backlog of incoming connection requests. If specified, must be a positive value. If not specified, each CM component will use its maximal allowed value, based on the system's setting.
uct_cm_listener_conn_request_callback_t	conn_request_cb	Callback function for handling incoming connection requests.
void ∗	user_data	User data associated with the listener.

6.18.2.5 struct uct_cm_ep_priv_data_pack_args

Used with the client-server API on a connection manager.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_cm_ep_priv_data_pack_args_field. Fields not specified by this mask should not be accessed by the callback.
char	dev_name[UCT_DEVICE_NAME_MAX]	Device name. This routine may fill the user's private data according to the given device name. The device name that is passed to this routine, corresponds to uct_tl_resource_desc_t::dev_name as returned from uct_md_query_tl_resources.

6.18.2.6 struct uct_cm_ep_resolve_args

Used with the client-server API on a connection manager.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_cm_ep_resolve_args_field. Fields not specified by this mask should not be accessed by the callback.
char	dev_name[UCT_DEVICE_NAME_MAX]	Device name indicates the device that the endpoint was bound to during address and route resolution. The device name that is passed to this callback corresponds to uct_tl_resource_desc_t::dev_name as returned from uct_md_query_tl_resources.
ucs_status_t	status	Indicates address resolution status: UCS_OK - address of the remote server was resolved successfully. UCS_ERR_UNREACHABLE - the remote server is unreachable. Otherwise - indicates an internal connection establishment error on the local (client) side.

6.18.2.7 struct uct_cm_remote_data

The remote peer's device address, the data received from it and their lengths. Used with the client-server API on a connection manager.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_cm_remote_data_field. Fields not specified by this mask will be ignored.
const uct_device_addr_t ∗	dev_addr	Device address of the remote peer.
size_t	dev_addr_length	Length of the remote device address.
const void ∗	conn_priv_data	Pointer to the received data. This is the private data that was passed to uct_ep_params_t::sockaddr_pack_cb.
size_t	conn_priv_data_length	Length of the received data from the peer.

6.18.2.8 struct uct_cm_listener_conn_request_args

The local device name, connection request handle and the data the client sent. Used with the client-server API on a connection manager.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_cm_listener_conn_request_args_field. Fields not specified by this mask should not be accessed by the callback.
char	dev_name[UCT_DEVICE_NAME_MAX]	Local device name which handles the incoming connection request.
uct_conn_request_h	conn_request	Connection request handle. Can be passed to this callback from the transport and will be used by it to accept or reject the connection request from the client.
const uct_cm_remote_data_t ∗	remote_data	Remote data from the client.
ucs_sock_addr_t	client_address	Client's address.

6.18.2.9 struct uct_cm_ep_client_connect_args

Used with the client-server API on a connection manager.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_cm_ep_client_connect_args_field. Fields not specified by this mask should not be accessed by the callback.
const uct_cm_remote_data_t ∗	remote_data	Remote data from the server.

Data Fields

ucs_status_t	status	Indicates the connection establishment response from the remote server: UCS_OK - the remote server accepted the connection request. UCS_ERR_REJECTED - the remote server rejected the connection request. UCS_ERR_CONNECTION_RESET - the server's connection was reset during the connection establishment to the client. Otherwise - indicates an internal connection establishment error on the local (client) side.

6.18.2.10 struct uct_cm_ep_server_conn_notify_args

Used with the client-server API on a connection manager.

Data Fields

uint64_t	field_mask	Mask of valid fields in this structure, using bits from uct_cm_ep_server_conn_notify_args_field. Fields not specified by this mask should not be accessed by the callback.
ucs_status_t	status	Indicates the client's ucs_status_t status: UCS_OK - the client completed its connection establishment and called uct_cm_client_ep_conn_notify UCS_ERR_CONNECTION_RESET - the client's connection was reset during the connection establishment to the server. Otherwise - indicates an internal connection establishment error on the local (server) side.

6.18.3 Typedef Documentation

6.18.3.1 uct_cm_ep_priv_data_pack_args_t

```
typedef struct uct_cm_ep_priv_data_pack_args uct_cm_ep_priv_data_pack_args_t
```

Used with the client-server API on a connection manager.

6.18.3.2 uct_cm_ep_resolve_args_t

```
typedef struct uct_cm_ep_resolve_args uct_cm_ep_resolve_args_t
```

Used with the client-server API on a connection manager.

6.18.3.3 uct_cm_remote_data_t

```
typedef struct uct_cm_remote_data uct_cm_remote_data_t
```

The remote peer's device address, the data received from it and their lengths. Used with the client-server API on a connection manager.

6.18.3.4 uct_cm_listener_conn_request_args_t

```
typedef struct uct_cm_listener_conn_request_args uct_cm_listener_conn_request_args_t
```

The local device name, connection request handle and the data the client sent. Used with the client-server API on a connection manager.

6.18.3.5 uct_cm_ep_client_connect_args_t

```
typedef struct uct_cm_ep_client_connect_args uct_cm_ep_client_connect_args_t
```

Used with the client-server API on a connection manager.

6.18.3.6 uct_cm_ep_server_conn_notify_args_t

```
typedef struct uct_cm_ep_server_conn_notify_args uct_cm_ep_server_conn_notify_args_t
```

Used with the client-server API on a connection manager.

6.18.3.7 uct_sockaddr_conn_request_callback_t

```
typedef void(* uct_sockaddr_conn_request_callback_t) (uct_iface_h iface, void *arg, uct_conn_request_h
conn_request, const void *conn_priv_data, size_t length)
```

This callback routine will be invoked on the server side upon receiving an incoming connection request. It should be set by the server side while initializing an interface. Incoming data is placed inside the conn_priv_data buffer. This callback has to be thread safe. Other than communication progress routines, it is allowed to call other UCT communication routines from this callback.

Parameters

in	*iface*	Transport interface.
in	*arg*	User defined argument for this callback.
in	*conn_request*	Transport level connection request. The user should accept or reject the request by calling uct_iface_accept or uct_iface_reject routines respectively. conn_request should not be used outside the scope of this callback.
in	*conn_priv_data*	Points to the received data. This is the private data that was passed to the uct_ep_params_t::sockaddr_pack_cb on the client side.
in	*length*	Length of the received data.

6.18.3.8 uct_cm_listener_conn_request_callback_t

```
typedef void(* uct_cm_listener_conn_request_callback_t) (uct_listener_h listener, void *arg,
const uct_cm_listener_conn_request_args_t *conn_req_args)
```

This callback routine will be invoked on the server side upon receiving an incoming connection request. It should be set by the server side while initializing a listener in a connection manager. This callback has to be thread safe. Other than communication progress routines, it is allowed to call other UCT communication routines from this callback.

Parameters

in	*listener*	Transport listener.
in	*arg*	User argument for this callback as defined in uct_listener_params_t::user_data
in	*conn_req_args*	Listener's arguments to handle the connection request from the client.

6.18.3.9 uct_cm_ep_server_conn_notify_callback_t

```
typedef void(* uct_cm_ep_server_conn_notify_callback_t) (uct_ep_h ep, void *arg, const uct_cm_ep_server_conn_n
*connect_args)
```

This callback routine will be invoked on the server side upon receiving an incoming connection establishment acknowledgment from the client, which is sent from it once the client is connected to the server. Used to connect the server side to the client or handle an error from it - depending on the status field. This callback will also be invoked in the event of an internal local error with a failed uct_cm_ep_server_conn_notify_args::status if the endpoint was not connected yet. This callback has to be thread safe. Other than communication progress routines, it is permissible to call other UCT communication routines from this callback.

Parameters

in	*ep*	Transport endpoint.
in	*arg*	User argument for this callback as defined in uct_ep_params_t::user_data
in	*connect_args*	Server's connect callback arguments.

6.18.3.10 uct_cm_ep_client_connect_callback_t

```
typedef void(* uct_cm_ep_client_connect_callback_t) (uct_ep_h ep, void *arg, const uct_cm_ep_client_connect_ar
*connect_args)
```

This callback routine will be invoked on the client side upon receiving an incoming connection response from the server. Used to connect the client side to the server or handle an error from it - depending on the status field. This callback will also be invoked in the event of an internal local error with a failed uct_cm_ep_client_connect_args::status if the endpoint was not connected yet. This callback has to be thread safe. Other than communication progress routines, it is permissible to call other UCT communication routines from this callback.

Parameters

in	*ep*	Transport endpoint.
in	*arg*	User argument for this callback as defined in uct_ep_params_t::user_data.
in	*connect_args*	Client's connect callback arguments

6.18.3.11 uct_ep_disconnect_cb_t

```
typedef void(* uct_ep_disconnect_cb_t) (uct_ep_h ep, void *arg)
```

This callback routine will be invoked on the client and server sides upon a disconnect of the remote peer. It will disconnect the given endpoint from the remote peer. This callback won't be invoked if the endpoint was not connected to the remote peer yet. This callback has to be thread safe. Other than communication progress routines, it is permissible to call other UCT communication routines from this callback.

Parameters

in	*ep*	Transport endpoint to disconnect.
in	*arg*	User argument for this callback as defined in uct_ep_params_t::user_data.

6.18.3.12 uct_cm_ep_priv_data_pack_callback_t

```
typedef ssize_t(* uct_cm_ep_priv_data_pack_callback_t) (void *arg, const uct_cm_ep_priv_data_pack_args_t
*pack_args, void *priv_data)
```

This callback routine will be invoked on the client side, before sending the transport's connection request to the server, or on the server side before sending a connection response to the client. This callback routine can be set when creating an endpoint. The user's private data should be placed inside the priv_data buffer to be sent to the remote side. The maximal allowed length of the private data is indicated by the field max_conn_priv inside uct_iface_attr or inside uct_cm_attr when using a connection manager. Communication progress routines should not be called from this callback. It is allowed to call other UCT communication routines from this callback.

Parameters

in	*arg*	User defined argument for this callback.
in	*pack_args*	Handle for the the private data packing.
out	*priv_data*	User's private data to be passed to the remote side.

Returns

Negative value indicates an error according to ucs_status_t. On success, a non-negative value indicates actual number of bytes written to the *priv_data* buffer.

6.18.3.13 uct_cm_ep_resolve_callback_t

```
typedef ucs_status_t(* uct_cm_ep_resolve_callback_t) (void *user_data, const uct_cm_ep_resolve_args_t
*resolve_args)
```

This callback routine will be invoked, when the client side endpoint is bound to a local device. The callback routine can be set when creating an endpoint. Communication progress routines should not be called from this callback. It is allowed to call other UCT communication routines from this callback.

Parameters

in	*user_data*	User argument as defined in uct_ep_params_t::user_data.
in	*resolve_args*	Handle for the extra arguments provided by the transport.

Returns

UCS_OK on success or error as defined in ucs_status_t.

6.18.4 Enumeration Type Documentation

6.18.4.1 uct_cm_attr_field

```
enum uct_cm_attr_field
```

The enumeration allows specifying which fields in uct_cm_attr_t are present, for backward compatibility support.

Enumerator

UCT_CM_ATTR_FIELD_MAX_CONN_PRIV	Enables uct_cm_attr::max_conn_priv

6.18.4.2 uct_listener_attr_field

```
enum uct_listener_attr_field
```

The enumeration allows specifying which fields in uct_listener_attr_t are present, for backward compatibility support.

Enumerator

UCT_LISTENER_ATTR_FIELD_SOCKADDR	Enables uct_listener_attr::sockaddr

6.18.4.3 uct_listener_params_field

```
enum uct_listener_params_field
```

The enumeration allows specifying which fields in uct_listener_params_t are present, for backward compatibility support.

Enumerator

UCT_LISTENER_PARAM_FIELD_BACKLOG	Enables uct_listener_params::backlog
UCT_LISTENER_PARAM_FIELD_CONN_REQUEST_CB	Enables uct_listener_params::conn_request_cb
UCT_LISTENER_PARAM_FIELD_USER_DATA	Enables uct_listener_params::user_data

6.18.4.4 uct_ep_connect_params_field

```
enum uct_ep_connect_params_field
```

The enumeration allows specifying which fields in uct_ep_connect_params_t are present, for backward compatibility support.

Enumerator

UCT_EP_CONNECT_PARAM_FIELD_PRIVATE_↩ DATA	Enables uct_ep_connect_params::private_data
UCT_EP_CONNECT_PARAM_FIELD_PRIVATE_↩ DATA_LENGTH	Enables uct_ep_connect_params::private_data_length

6.18.4.5 uct_cm_ep_priv_data_pack_args_field

```
enum uct_cm_ep_priv_data_pack_args_field
```

The enumeration allows specifying which fields in uct_cm_ep_priv_data_pack_args are present, for backward compatibility support.

Enumerator

UCT_CM_EP_PRIV_DATA_PACK_ARGS_FIELD↩_DEVICE_NAME	Enables uct_cm_ep_priv_data_pack_args::dev_name Indicates that dev_name field in uct_cm_ep_priv_data_pack_args_t is valid.

6.18.4.6 uct_cm_ep_resolve_args_field

```
enum uct_cm_ep_resolve_args_field
```

The enumeration allows specifying which fields in uct_cm_ep_resolve_args are present, for backward compatibility support.

Enumerator

UCT_CM_EP_RESOLVE_ARGS_FIELD_DEV_N↩AME	Indicates that uct_cm_ep_resolve_args::dev_name is valid.
UCT_CM_EP_RESOLVE_ARGS_FIELD_STATUS	Indicates that uct_cm_ep_resolve_args::status is valid.

6.18.4.7 uct_cm_remote_data_field

```
enum uct_cm_remote_data_field
```

The enumeration allows specifying which fields in uct_cm_remote_data are present, for backward compatibility support.

Enumerator

UCT_CM_REMOTE_DATA_FIELD_DEV_ADDR	Enables uct_cm_remote_data::dev_addr
UCT_CM_REMOTE_DATA_FIELD_DEV_ADDR_↩LENGTH	Enables uct_cm_remote_data::dev_addr_length
UCT_CM_REMOTE_DATA_FIELD_CONN_PRIV_↩DATA	Enables uct_cm_remote_data::conn_priv_data
UCT_CM_REMOTE_DATA_FIELD_CONN_PRIV_↩DATA_LENGTH	Enables uct_cm_remote_data::conn_priv_data_length

6.18.4.8 uct_cm_listener_conn_request_args_field

```
enum uct_cm_listener_conn_request_args_field
```

The enumeration allows specifying which fields in uct_cm_listener_conn_request_args are present, for backward compatibility support.

Enumerator

Enumerator

UCT_CM_LISTENER_CONN_REQUEST_ARGS_↩ FIELD_DEV_NAME	Enables uct_cm_listener_conn_request_args::dev_name Indicates that dev_name field in uct_cm_listener_conn_request_args_t is valid.
UCT_CM_LISTENER_CONN_REQUEST_ARGS_↩ FIELD_CONN_REQUEST	Enables uct_cm_listener_conn_request_args::conn_request Indicates that conn_request field in uct_cm_listener_conn_request_args_t is valid.
UCT_CM_LISTENER_CONN_REQUEST_ARGS_↩ FIELD_REMOTE_DATA	Enables uct_cm_listener_conn_request_args::remote_data Indicates that remote_data field in uct_cm_listener_conn_request_args_t is valid.
UCT_CM_LISTENER_CONN_REQUEST_ARGS_↩ FIELD_CLIENT_ADDR	Enables uct_cm_listener_conn_request_args::client_address Indicates that client_address field in uct_cm_listener_conn_request_args_t is valid.

6.18.4.9 uct_cm_ep_client_connect_args_field

`enum uct_cm_ep_client_connect_args_field`

The enumeration allows specifying which fields in uct_cm_ep_client_connect_args are present, for backward compatibility support.

Enumerator

UCT_CM_EP_CLIENT_CONNECT_ARGS_FIELD↩ _REMOTE_DATA	Enables uct_cm_ep_client_connect_args::remote_data
UCT_CM_EP_CLIENT_CONNECT_ARGS_FIELD↩ _STATUS	Enables uct_cm_ep_client_connect_args::status

6.18.4.10 uct_cm_ep_server_conn_notify_args_field

`enum uct_cm_ep_server_conn_notify_args_field`

The enumeration allows specifying which fields in uct_cm_ep_server_conn_notify_args are present, for backward compatibility support.

Enumerator

UCT_CM_EP_SERVER_CONN_NOTIFY_ARGS_↩ FIELD_STATUS	Enables uct_cm_ep_server_conn_notify_args::status Indicates that status field in uct_cm_ep_server_conn_notify_args_t is valid.

6.18.5 Function Documentation

6.18.5.1 uct_iface_accept()

```
ucs_status_t uct_iface_accept (
            uct_iface_h iface,
            uct_conn_request_h conn_request )
```

Parameters

in	*iface*	Transport interface which generated connection request *conn_request*.
in	*conn_request*	Connection establishment request passed as parameter of uct_sockaddr_conn_request_callback_t.

Returns

Error code as defined by ucs_status_t

6.18.5.2 uct_iface_reject()

```
ucs_status_t uct_iface_reject (
            uct_iface_h iface,
            uct_conn_request_h conn_request )
```

Parameters

in	*iface*	Interface which generated connection establishment request *conn_request*.
in	*conn_request*	Connection establishment request passed as parameter of uct_sockaddr_conn_request_callback_t.

Returns

Error code as defined by ucs_status_t

6.18.5.3 uct_ep_connect()

```
ucs_status_t uct_ep_connect (
            uct_ep_h ep,
            const uct_ep_connect_params_t * params )
```

This non-blocking routine establishes connection of the client side endpoint and sends private data to the peer.

Parameters

in	*ep*	Endpoint to connect.
in	*params*	Parameters as defined in uct_ep_connect_params_t.

Returns

UCS_OK Operation has been initiated successfully. Other error codes as defined by ucs_status_t.

6.18.5.4 uct_ep_disconnect()

```
ucs_status_t uct_ep_disconnect (
             uct_ep_h ep,
             unsigned flags )
```

This non-blocking routine will send a disconnect notification on the endpoint, so that uct_ep_disconnect_cb_t will be called on the remote peer. The remote side should also call this routine when handling the initiator's disconnect. After a call to this function, the given endpoint may not be used for communications anymore. The uct_ep_flush / uct_iface_flush routines will guarantee that the disconnect notification is delivered to the remote peer. uct_ep_destroy should be called on this endpoint after invoking this routine and uct_ep_params::disconnect_cb was called.

Parameters

in	*ep*	Endpoint to disconnect.
in	*flags*	Reserved for future use.

Returns

UCS_OK Operation has completed successfully. UCS_ERR_BUSY The *ep* is not connected yet (either uct_cm_ep_client_connect_callback_t or uct_cm_ep_server_conn_notify_callback_t was not invoked). U↩
CS_INPROGRESS The disconnect request has been initiated, but the remote peer has not yet responded to this request, and consequently the registered callback uct_ep_disconnect_cb_t has not been invoked to handle the request. UCS_ERR_NOT_CONNECTED The *ep* is disconnected locally and remotely. Other error codes as defined by ucs_status_t .

6.18.5.5 uct_cm_open()

```
ucs_status_t uct_cm_open (
             uct_component_h component,
             uct_worker_h worker,
             const uct_cm_config_t * config,
             uct_cm_h * cm_p )
```

Open a connection manager. All client server connection establishment operations are performed in the context of a specific connection manager.

Note

This is an alternative API for uct_iface_open_mode::UCT_IFACE_OPEN_MODE_SOCKADDR_SERVER and uct_iface_open_mode::UCT_IFACE_OPEN_MODE_SOCKADDR_CLIENT .

Parameters

in	*component*	Component on which to open the connection manager, as returned from uct_query_components.
in	*worker*	Worker on which to open the connection manager.

Parameters

in	*config*	CM configuration options. Either obtained from uct_cm_config_read() function, or pointer to CM-specific structure that extends uct_cm_config_t.
out	*cm_p*	Filled with a handle to the connection manager.

Returns

Error code.

6.18.5.6 uct_cm_close()

```
void uct_cm_close (
            uct_cm_h cm )
```

Parameters

in	*cm*	Connection manager to close.

6.18.5.7 uct_cm_query()

```
ucs_status_t uct_cm_query (
            uct_cm_h cm,
            uct_cm_attr_t * cm_attr )
```

This routine queries the cm for its attributes uct_cm_attr_t.

Parameters

in	*cm*	Connection manager to query.
out	*cm_attr*	Filled with connection manager attributes.

6.18.5.8 uct_cm_config_read()

```
ucs_status_t uct_cm_config_read (
            uct_component_h component,
            const char * env_prefix,
            const char * filename,
            uct_cm_config_t ** config_p )
```

Parameters

in	*component*	Read the configuration of the connection manager on this component.
in	*env_prefix*	If non-NULL, search for environment variables starting with this UCT_<prefix>_. Otherwise, search for environment variables starting with just UCT_.
in	*filename*	If non-NULL, read configuration from this file. If the file does not exist, or exists but cannot be opened or read, it will be ignored.

Parameters

out	*config_p*	Filled with a pointer to the configuration.

Returns

Error code.

6.18.5.9 uct_cm_client_ep_conn_notify()

```
ucs_status_t uct_cm_client_ep_conn_notify (
             uct_ep_h ep )
```

This routine should be called on the client side after the client completed establishing its connection to the server. The routine will send a notification message to the server indicating that the client is connected.

Parameters

in	*ep*	The connected endpoint on the client side.

Returns

Error code.

6.18.5.10 uct_listener_create()

```
ucs_status_t uct_listener_create (
             uct_cm_h cm,
             const struct sockaddr * saddr,
             socklen_t socklen,
             const uct_listener_params_t * params,
             uct_listener_h * listener_p )
```

This routine creates a new listener on the given CM which will start listening on a given sockaddr.

Parameters

in	*cm*	Connection manager on which to open the listener. This cm should not be closed as long as there are open listeners on it.
in	*saddr*	The socket address to listen on.
in	*socklen*	The saddr length.
in	*params*	User defined uct_listener_params_t configurations for the *listener_p*.
out	*listener←_p*	Filled with handle to the new listener.

Returns

Error code.

6.18.5.11 uct_listener_destroy()

```
void uct_listener_destroy (
            uct_listener_h listener )
```

Parameters

in	*listener*	Listener to destroy.

6.18.5.12 uct_listener_reject()

```
ucs_status_t uct_listener_reject (
            uct_listener_h listener,
            uct_conn_request_h conn_request )
```

This routine can be invoked on the server side. It rejects a connection request from the client.

Parameters

in	*listener*	Listener which will reject the connection request.
in	*conn_request*	Connection establishment request passed as parameter of uct_cm_listener_conn_request_callback_t in uct_cm_listener_conn_request_args_t::conn_request.

Returns

Error code as defined by ucs_status_t

6.18.5.13 uct_listener_query()

```
ucs_status_t uct_listener_query (
            uct_listener_h listener,
            uct_listener_attr_t * listener_attr )
```

This routine queries the listener for its attributes uct_listener_attr_t.

Parameters

in	*listener*	Listener object to query.
out	*listener_attr*	Filled with attributes of the listener.

Returns

Error code as defined by ucs_status_t

6.19 UCT interface operations and capabilities

List of capabilities supported by UCX API.

Macros

- #define UCT_IFACE_FLAG_AM_SHORT UCS_BIT(0)
- #define UCT_IFACE_FLAG_AM_BCOPY UCS_BIT(1)
- #define UCT_IFACE_FLAG_AM_ZCOPY UCS_BIT(2)
- #define UCT_IFACE_FLAG_PENDING UCS_BIT(3)
- #define UCT_IFACE_FLAG_PUT_SHORT UCS_BIT(4)
- #define UCT_IFACE_FLAG_PUT_BCOPY UCS_BIT(5)
- #define UCT_IFACE_FLAG_PUT_ZCOPY UCS_BIT(6)
- #define UCT_IFACE_FLAG_GET_SHORT UCS_BIT(8)
- #define UCT_IFACE_FLAG_GET_BCOPY UCS_BIT(9)
- #define UCT_IFACE_FLAG_GET_ZCOPY UCS_BIT(10)
- #define UCT_IFACE_FLAG_ATOMIC_CPU UCS_BIT(30)
- #define UCT_IFACE_FLAG_ATOMIC_DEVICE UCS_BIT(31)
- #define UCT_IFACE_FLAG_ERRHANDLE_SHORT_BUF UCS_BIT(32)
- #define UCT_IFACE_FLAG_ERRHANDLE_BCOPY_BUF UCS_BIT(33)
- #define UCT_IFACE_FLAG_ERRHANDLE_ZCOPY_BUF UCS_BIT(34)
- #define UCT_IFACE_FLAG_ERRHANDLE_AM_ID UCS_BIT(35)
- #define UCT_IFACE_FLAG_ERRHANDLE_REMOTE_MEM UCS_BIT(36)
- #define UCT_IFACE_FLAG_ERRHANDLE_BCOPY_LEN UCS_BIT(37)
- #define UCT_IFACE_FLAG_ERRHANDLE_PEER_FAILURE UCS_BIT(38)
- #define UCT_IFACE_FLAG_EP_CHECK UCS_BIT(39)
- #define UCT_IFACE_FLAG_CONNECT_TO_IFACE UCS_BIT(40)
- #define UCT_IFACE_FLAG_CONNECT_TO_EP UCS_BIT(41)
- #define UCT_IFACE_FLAG_CONNECT_TO_SOCKADDR UCS_BIT(42)
- #define UCT_IFACE_FLAG_AM_DUP UCS_BIT(43)
- #define UCT_IFACE_FLAG_CB_SYNC UCS_BIT(44)
- #define UCT_IFACE_FLAG_CB_ASYNC UCS_BIT(45)
- #define UCT_IFACE_FLAG_EP_KEEPALIVE UCS_BIT(46)
- #define UCT_IFACE_FLAG_TAG_EAGER_SHORT UCS_BIT(50)
- #define UCT_IFACE_FLAG_TAG_EAGER_BCOPY UCS_BIT(51)
- #define UCT_IFACE_FLAG_TAG_EAGER_ZCOPY UCS_BIT(52)
- #define UCT_IFACE_FLAG_TAG_RNDV_ZCOPY UCS_BIT(53)
- #define UCT_IFACE_FLAG_INTER_NODE UCS_BIT(54)

6.19.1 Detailed Description

The definition list presents a full list of operations and capabilities exposed by UCX API.

6.19.2 Macro Definition Documentation

6.19.2.1 UCT_IFACE_FLAG_AM_SHORT

```
#define UCT_IFACE_FLAG_AM_SHORT UCS_BIT(0)
```

Short active message

Examples:

uct_hello_world.c.

6.19.2.2 UCT_IFACE_FLAG_AM_BCOPY

```
#define UCT_IFACE_FLAG_AM_BCOPY UCS_BIT(1)
```

Buffered active message

Examples:

uct_hello_world.c.

6.19.2.3 UCT_IFACE_FLAG_AM_ZCOPY

```
#define UCT_IFACE_FLAG_AM_ZCOPY UCS_BIT(2)
```

Zero-copy active message

Examples:

uct_hello_world.c.

6.19.2.4 UCT_IFACE_FLAG_PENDING

```
#define UCT_IFACE_FLAG_PENDING UCS_BIT(3)
```

Pending operations

6.19.2.5 UCT_IFACE_FLAG_PUT_SHORT

```
#define UCT_IFACE_FLAG_PUT_SHORT UCS_BIT(4)
```

Short put

6.19.2.6 UCT_IFACE_FLAG_PUT_BCOPY

```
#define UCT_IFACE_FLAG_PUT_BCOPY UCS_BIT(5)
```

Buffered put

6.19.2.7 UCT_IFACE_FLAG_PUT_ZCOPY

```
#define UCT_IFACE_FLAG_PUT_ZCOPY UCS_BIT(6)
```

Zero-copy put

6.19.2.8 UCT_IFACE_FLAG_GET_SHORT

```
#define UCT_IFACE_FLAG_GET_SHORT UCS_BIT(8)
```

Short get

6.19.2.9 UCT_IFACE_FLAG_GET_BCOPY

```
#define UCT_IFACE_FLAG_GET_BCOPY UCS_BIT(9)
```

Buffered get

6.19.2.10 UCT_IFACE_FLAG_GET_ZCOPY

```
#define UCT_IFACE_FLAG_GET_ZCOPY UCS_BIT(10)
```

Zero-copy get

6.19.2.11 UCT_IFACE_FLAG_ATOMIC_CPU

```
#define UCT_IFACE_FLAG_ATOMIC_CPU UCS_BIT(30)
```

Atomic communications are consistent with respect to CPU operations.

6.19.2.12 UCT_IFACE_FLAG_ATOMIC_DEVICE

```
#define UCT_IFACE_FLAG_ATOMIC_DEVICE UCS_BIT(31)
```

Atomic communications are consistent only with respect to other atomics on the same device.

6.19.2.13 UCT_IFACE_FLAG_ERRHANDLE_SHORT_BUF

```
#define UCT_IFACE_FLAG_ERRHANDLE_SHORT_BUF UCS_BIT(32)
```

Invalid buffer for short operation

6.19.2.14 UCT_IFACE_FLAG_ERRHANDLE_BCOPY_BUF

```
#define UCT_IFACE_FLAG_ERRHANDLE_BCOPY_BUF UCS_BIT(33)
```

Invalid buffer for buffered operation

6.19.2.15 UCT_IFACE_FLAG_ERRHANDLE_ZCOPY_BUF

```
#define UCT_IFACE_FLAG_ERRHANDLE_ZCOPY_BUF UCS_BIT(34)
```

Invalid buffer for zero copy operation

6.19.2.16 UCT_IFACE_FLAG_ERRHANDLE_AM_ID

```
#define UCT_IFACE_FLAG_ERRHANDLE_AM_ID UCS_BIT(35)
```

Invalid AM id on remote

6.19.2.17 UCT_IFACE_FLAG_ERRHANDLE_REMOTE_MEM

```
#define UCT_IFACE_FLAG_ERRHANDLE_REMOTE_MEM UCS_BIT(36)
```

Remote memory access

6.19.2.18 UCT_IFACE_FLAG_ERRHANDLE_BCOPY_LEN

```
#define UCT_IFACE_FLAG_ERRHANDLE_BCOPY_LEN UCS_BIT(37)
```

Invalid length for buffered operation

6.19.2.19 UCT_IFACE_FLAG_ERRHANDLE_PEER_FAILURE

```
#define UCT_IFACE_FLAG_ERRHANDLE_PEER_FAILURE UCS_BIT(38)
```

Remote peer failures/outage

6.19.2.20 UCT_IFACE_FLAG_EP_CHECK

```
#define UCT_IFACE_FLAG_EP_CHECK UCS_BIT(39)
```

Endpoint check

6.19.2.21 UCT_IFACE_FLAG_CONNECT_TO_IFACE

```
#define UCT_IFACE_FLAG_CONNECT_TO_IFACE UCS_BIT(40)
```

Supports connecting to interface

Examples:

uct_hello_world.c.

6.19.2.22 UCT_IFACE_FLAG_CONNECT_TO_EP

```
#define UCT_IFACE_FLAG_CONNECT_TO_EP UCS_BIT(41)
```

Supports connecting to specific endpoint

Examples:

uct_hello_world.c.

6.19.2.23 UCT_IFACE_FLAG_CONNECT_TO_SOCKADDR

```
#define UCT_IFACE_FLAG_CONNECT_TO_SOCKADDR UCS_BIT(42)
```

Supports connecting to sockaddr

6.19.2.24 UCT_IFACE_FLAG_AM_DUP

```
#define UCT_IFACE_FLAG_AM_DUP UCS_BIT(43)
```

Active messages may be received with duplicates This happens if the transport does not keep enough information to detect retransmissions

6.19.2.25 UCT_IFACE_FLAG_CB_SYNC

```
#define UCT_IFACE_FLAG_CB_SYNC UCS_BIT(44)
```

Interface supports setting a callback which is invoked only from the calling context of uct_worker_progress()

6.19.2.26 UCT_IFACE_FLAG_CB_ASYNC

```
#define UCT_IFACE_FLAG_CB_ASYNC UCS_BIT(45)
```

Interface supports setting a callback which will be invoked within a reasonable amount of time if uct_worker_progress() is not being called. The callback can be invoked from any progress context and it may also be invoked when uct_worker_progress() is called.

6.19.2.27 UCT_IFACE_FLAG_EP_KEEPALIVE

```
#define UCT_IFACE_FLAG_EP_KEEPALIVE UCS_BIT(46)
```

Transport endpoint has built-in keepalive feature, which guarantees the error callback on the transport interface will be called if the communication channel with remote peer is broken, even if there are no outstanding send operations

6.19.2.28 UCT_IFACE_FLAG_TAG_EAGER_SHORT

```
#define UCT_IFACE_FLAG_TAG_EAGER_SHORT UCS_BIT(50)
```

Hardware tag matching short eager support

6.19.2.29 UCT_IFACE_FLAG_TAG_EAGER_BCOPY

```
#define UCT_IFACE_FLAG_TAG_EAGER_BCOPY UCS_BIT(51)
```

Hardware tag matching bcopy eager support

6.19.2.30 UCT_IFACE_FLAG_TAG_EAGER_ZCOPY

```
#define UCT_IFACE_FLAG_TAG_EAGER_ZCOPY UCS_BIT(52)
```

Hardware tag matching zcopy eager support

6.19.2.31 UCT_IFACE_FLAG_TAG_RNDV_ZCOPY

```
#define UCT_IFACE_FLAG_TAG_RNDV_ZCOPY UCS_BIT(53)
```

Hardware tag matching rendezvous zcopy support

6.19.2.32 UCT_IFACE_FLAG_INTER_NODE

```
#define UCT_IFACE_FLAG_INTER_NODE UCS_BIT(54)
```

Interface is inter-node capable

6.20 UCT interface for asynchronous event capabilities

List of capabilities supported by UCT iface event API.

Macros

- #define UCT_IFACE_FLAG_EVENT_SEND_COMP UCS_BIT(0)
- #define UCT_IFACE_FLAG_EVENT_RECV UCS_BIT(1)
- #define UCT_IFACE_FLAG_EVENT_RECV_SIG UCS_BIT(2)
- #define UCT_IFACE_FLAG_EVENT_FD UCS_BIT(3)
- #define UCT_IFACE_FLAG_EVENT_ASYNC_CB UCS_BIT(4)

6.20.1 Detailed Description

The definition list presents a full list of operations and capabilities supported by UCT iface event.

6.20.2 Macro Definition Documentation

6.20.2.1 UCT_IFACE_FLAG_EVENT_SEND_COMP

```
#define UCT_IFACE_FLAG_EVENT_SEND_COMP UCS_BIT(0)
```

Event notification of send completion is supported

6.20.2.2 UCT_IFACE_FLAG_EVENT_RECV

```
#define UCT_IFACE_FLAG_EVENT_RECV UCS_BIT(1)
```

Event notification of tag and active message receive is supported

6.20.2.3 UCT_IFACE_FLAG_EVENT_RECV_SIG

```
#define UCT_IFACE_FLAG_EVENT_RECV_SIG UCS_BIT(2)
```

Event notification of signaled tag and active message is supported

6.20.2.4 UCT_IFACE_FLAG_EVENT_FD

```
#define UCT_IFACE_FLAG_EVENT_FD UCS_BIT(3)
```

Event notification through File Descriptor is supported

6.20.2.5 UCT_IFACE_FLAG_EVENT_ASYNC_CB

```
#define UCT_IFACE_FLAG_EVENT_ASYNC_CB UCS_BIT(4)
```

Event notification through asynchronous callback invocation is supported

6.21 Unified Communication Services (UCS) API

Modules

- UCS Communication Resource

6.21.1 Detailed Description

This section describes UCS API.

6.22 UCS Communication Resource

Data Structures

- struct ucs_sock_addr

Typedefs

- typedef void(∗ ucs_async_event_cb_t) (int id, ucs_event_set_types_t events, void ∗arg)
- typedef struct ucs_sock_addr ucs_sock_addr_t
- typedef enum ucs_memory_type ucs_memory_type_t

    Memory types.
- typedef unsigned long ucs_time_t
- typedef void ∗ ucs_status_ptr_t

    Status pointer.

Enumerations

- enum ucs_callbackq_flags { UCS_CALLBACKQ_FLAG_FAST = UCS_BIT(0), UCS_CALLBACKQ_FLAG_ONESHOT = UCS_BIT(1) }
- enum ucs_memory_type {
UCS_MEMORY_TYPE_HOST, UCS_MEMORY_TYPE_CUDA, UCS_MEMORY_TYPE_CUDA_MANAGED, UCS_MEMORY_TYPE_ROCM,
UCS_MEMORY_TYPE_ROCM_MANAGED, UCS_MEMORY_TYPE_RDMA, UCS_MEMORY_TYPE_ZE_HOST, UCS_MEMORY_TYPE_ZE_DEVICE,
UCS_MEMORY_TYPE_ZE_MANAGED, UCS_MEMORY_TYPE_LAST, UCS_MEMORY_TYPE_UNKNOWN = UCS_MEMORY_TYPE_LAST }

    Memory types.
- enum ucs_status_t {
UCS_OK = 0, UCS_INPROGRESS = 1, UCS_ERR_NO_MESSAGE = -1, UCS_ERR_NO_RESOURCE = -2,
UCS_ERR_IO_ERROR = -3, UCS_ERR_NO_MEMORY = -4, UCS_ERR_INVALID_PARAM = -5, UCS_ERR_UNREACHABLE = -6,
UCS_ERR_INVALID_ADDR = -7, UCS_ERR_NOT_IMPLEMENTED = -8, UCS_ERR_MESSAGE_TRUNCATED = -9, UCS_ERR_NO_PROGRESS = -10,
UCS_ERR_BUFFER_TOO_SMALL = -11, UCS_ERR_NO_ELEM = -12, UCS_ERR_SOME_CONNECTS_FAILED = -13, UCS_ERR_NO_DEVICE = -14,
UCS_ERR_BUSY = -15, UCS_ERR_CANCELED = -16, UCS_ERR_SHMEM_SEGMENT = -17, UCS_ERR_ALREADY_EXISTS = -18,
UCS_ERR_OUT_OF_RANGE = -19, UCS_ERR_TIMED_OUT = -20, UCS_ERR_EXCEEDS_LIMIT = -21, UCS_ERR_UNSUPPORTED = -22,
UCS_ERR_REJECTED = -23, UCS_ERR_NOT_CONNECTED = -24, UCS_ERR_CONNECTION_RESET = -25, UCS_ERR_FIRST_LINK_FAILURE = -40,
UCS_ERR_LAST_LINK_FAILURE = -59, UCS_ERR_FIRST_ENDPOINT_FAILURE = -60, UCS_ERR_ENDPOINT_TIMEOUT = -80, UCS_ERR_LAST_ENDPOINT_FAILURE = -89,
UCS_ERR_LAST = -100 }

    Status codes.
- enum ucs_thread_mode_t { UCS_THREAD_MODE_SINGLE, UCS_THREAD_MODE_SERIALIZED, UCS_THREAD_MODE_MULTI, UCS_THREAD_MODE_LAST }

    Thread sharing mode.

Functions

- ucs_status_t ucs_async_set_event_handler (ucs_async_mode_t mode, int event_fd, ucs_event_set_types↩ _t events, ucs_async_event_cb_t cb, void ∗arg, ucs_async_context_t ∗async)
- ucs_status_t ucs_async_add_timer (ucs_async_mode_t mode, ucs_time_t interval, ucs_async_event_cb_t cb, void ∗arg, ucs_async_context_t ∗async, int ∗timer_id_p)
- ucs_status_t ucs_async_remove_handler (int id, int sync)
- ucs_status_t ucs_async_modify_handler (int fd, ucs_event_set_types_t events)
- ucs_status_t ucs_async_context_create (ucs_async_mode_t mode, ucs_async_context_t ∗∗async_p)

  Create an asynchronous execution context.
- void ucs_async_context_destroy (ucs_async_context_t ∗async)

  Destroy the asynchronous execution context.
- void ucs_async_poll (ucs_async_context_t ∗async)

6.22.1 Detailed Description

This section describes a concept of the Communication Resource and routines associated with the concept.

6.22.2 Data Structure Documentation

6.22.2.1 struct ucs_sock_addr

BSD socket address specification.

Data Fields

const struct sockaddr ∗	addr	Pointer to socket address
socklen_t	addrlen	Address length

6.22.3 Typedef Documentation

6.22.3.1 ucs_async_event_cb_t

```
typedef void(∗ ucs_async_event_cb_t) (int id, ucs_event_set_types_t events, void ∗arg)
```

Async event callback.

Parameters

id	Event id (timer or file descriptor).
events	The events that triggered the callback.
arg	User-defined argument.

6.22.3.2 ucs_sock_addr_t

```
typedef struct ucs_sock_addr ucs_sock_addr_t
```

BSD socket address specification.

6.22.3.3 ucs_memory_type_t

```
typedef enum ucs_memory_type ucs_memory_type_t
```

List of supported memory types.

6.22.3.4 ucs_time_t

```
typedef unsigned long ucs_time_t
```

UCS time units. These are not necessarily aligned with metric time units. MUST compare short time values with UCS_SHORT_TIME_CMP to handle wrap-around.

6.22.3.5 ucs_status_ptr_t

```
typedef void* ucs_status_ptr_t
```

A pointer can represent one of these values:

- NULL / UCS_OK
- Error code pointer (UCS_ERR_xx)
- Valid pointer

6.22.4 Enumeration Type Documentation

6.22.4.1 ucs_callbackq_flags

```
enum ucs_callbackq_flags
```

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Callback backward compatibility flags

Enumerator

UCS_CALLBACKQ_FLAG_FAST	Fast-path (best effort)
UCS_CALLBACKQ_FLAG_ONESHOT	Call the callback only once (cannot be used with FAST)

6.22.4.2 ucs_memory_type

```
enum ucs_memory_type
```

List of supported memory types.

Enumerator

UCS_MEMORY_TYPE_HOST	Default system memory

Enumerator

UCS_MEMORY_TYPE_CUDA	NVIDIA CUDA memory
UCS_MEMORY_TYPE_CUDA_MANAGED	NVIDIA CUDA managed (or unified) memory
UCS_MEMORY_TYPE_ROCM	AMD ROCM memory
UCS_MEMORY_TYPE_ROCM_MANAGED	AMD ROCM managed system memory
UCS_MEMORY_TYPE_RDMA	RDMA device memory
UCS_MEMORY_TYPE_ZE_HOST	Intel ZE memory (USM host)
UCS_MEMORY_TYPE_ZE_DEVICE	Intel ZE memory (USM device)
UCS_MEMORY_TYPE_ZE_MANAGED	Intel ZE managed memory (USM shared)
UCS_MEMORY_TYPE_LAST	
UCS_MEMORY_TYPE_UNKNOWN	

6.22.4.3 ucs_status_t

```
enum ucs_status_t
```

Note

In order to evaluate the necessary steps to recover from a certain error, all error codes which can be returned by the external API are grouped by the largest entity permanently effected by the error. Each group ranges between its UCS_ERR_FIRST_<name> and UCS_ERR_LAST_<name> enum values. For example, if a link fails it may be sufficient to destroy (and possibly replace) it, in contrast to an endpoint-level error.

Enumerator

UCS_OK	
UCS_INPROGRESS	
UCS_ERR_NO_MESSAGE	
UCS_ERR_NO_RESOURCE	
UCS_ERR_IO_ERROR	
UCS_ERR_NO_MEMORY	
UCS_ERR_INVALID_PARAM	
UCS_ERR_UNREACHABLE	
UCS_ERR_INVALID_ADDR	
UCS_ERR_NOT_IMPLEMENTED	
UCS_ERR_MESSAGE_TRUNCATED	
UCS_ERR_NO_PROGRESS	
UCS_ERR_BUFFER_TOO_SMALL	
UCS_ERR_NO_ELEM	
UCS_ERR_SOME_CONNECTS_FAILED	
UCS_ERR_NO_DEVICE	
UCS_ERR_BUSY	
UCS_ERR_CANCELED	
UCS_ERR_SHMEM_SEGMENT	
UCS_ERR_ALREADY_EXISTS	
UCS_ERR_OUT_OF_RANGE	
UCS_ERR_TIMED_OUT	
UCS_ERR_EXCEEDS_LIMIT	
UCS_ERR_UNSUPPORTED	

Enumerator

UCS_ERR_REJECTED	
UCS_ERR_NOT_CONNECTED	
UCS_ERR_CONNECTION_RESET	
UCS_ERR_FIRST_LINK_FAILURE	
UCS_ERR_LAST_LINK_FAILURE	
UCS_ERR_FIRST_ENDPOINT_FAILURE	
UCS_ERR_ENDPOINT_TIMEOUT	
UCS_ERR_LAST_ENDPOINT_FAILURE	
UCS_ERR_LAST	

Examples:

uct_hello_world.c.

6.22.4.4 ucs_thread_mode_t

```
enum ucs_thread_mode_t
```

Specifies thread sharing mode of an object.

Enumerator

UCS_THREAD_MODE_SINGLE	Only the master thread can access (i.e. the thread that initialized the context; multiple threads may exist and never access)
UCS_THREAD_MODE_SERIALIZED	Multiple threads can access, but only one at a time
UCS_THREAD_MODE_MULTI	Multiple threads can access concurrently
UCS_THREAD_MODE_LAST	

6.22.5 Function Documentation

6.22.5.1 ucs_async_set_event_handler()

```
ucs_status_t ucs_async_set_event_handler (
              ucs_async_mode_t mode,
              int event_fd,
              ucs_event_set_types_t events,
              ucs_async_event_cb_t cb,
              void * arg,
              ucs_async_context_t * async )
```

Register a file descriptor for monitoring (call handler upon events). Every fd can have only one handler.

Parameters

mode	Thread or signal.
event←_fd	File descriptor to set handler for.

Parameters

events	Events to wait on (UCS_EVENT_SET_EVxxx bits).
cb	Callback function to execute.
arg	Argument to callback.
async	Async context to which events are delivered. If NULL, safety is up to the user.

Returns

Error code as defined by ucs_status_t.

6.22.5.2 ucs_async_add_timer()

```
ucs_status_t ucs_async_add_timer (
            ucs_async_mode_t mode,
            ucs_time_t interval,
            ucs_async_event_cb_t cb,
            void * arg,
            ucs_async_context_t * async,
            int * timer_id_p )
```

Add timer handler.

Parameters

mode	Thread or signal.
interval	Timer interval.
cb	Callback function to execute.
arg	Argument to callback.
async	Async context to which events are delivered. If NULL, safety is up to the user.
timer_id_p	Filled with timer id.

Returns

Error code as defined by ucs_status_t.

6.22.5.3 ucs_async_remove_handler()

```
ucs_status_t ucs_async_remove_handler (
            int id,
            int sync )
```

Remove an event handler (Timer or event file).

Parameters

id	Timer/FD to remove.
sync	If nonzero, wait until the handler for this event is not running anymore. If called from the context of the callback, the handler will be removed immediately after the current callback returns.

Returns

Error code as defined by ucs_status_t.

6.22.5.4 ucs_async_modify_handler()

```
ucs_status_t ucs_async_modify_handler (
             int fd,
             ucs_event_set_types_t events )
```

Modify events mask for an existing event handler (event file).

Parameters

fd	File descriptor modify events for.
events	New set of events to wait on (UCS_EVENT_SET_EVxxx bits).

Returns

Error code as defined by ucs_status_t.

6.22.5.5 ucs_async_context_create()

```
ucs_status_t ucs_async_context_create (
             ucs_async_mode_t mode,
             ucs_async_context_t ** async_p )
```

Allocate and initialize an asynchronous execution context. This can be used to ensure safe event delivery.

Parameters

mode	Indicates whether to use signals or polling threads for waiting.
async←_p	Event context pointer to initialize.

Returns

Error code as defined by ucs_status_t.

Examples:

uct_hello_world.c.

6.22.5.6 ucs_async_context_destroy()

```
void ucs_async_context_destroy (
             ucs_async_context_t * async )
```

Clean up the async context, and release system resources if possible. The context memory released.

Parameters

async	Asynchronous context to clean up.

Examples:

uct_hello_world.c.

6.22.5.7 ucs_async_poll()

```
void ucs_async_poll (
             ucs_async_context_t * async )
```

Poll on async context.

Parameters

async	Async context to poll on. NULL polls on all.

Chapter 7

Data Structure Documentation

7.1 ucp_generic_dt_ops Struct Reference

UCP generic data type descriptor.

Data Fields

- void ∗(∗ start_pack)(void ∗context, const void ∗buffer, size_t count)

    Start a packing request.
- void ∗(∗ start_unpack)(void ∗context, void ∗buffer, size_t count)

    Start an unpacking request.
- size_t(∗ packed_size)(void ∗state)

    Get the total size of packed data.
- size_t(∗ pack)(void ∗state, size_t offset, void ∗dest, size_t max_length)

    Pack data.
- ucs_status_t(∗ unpack)(void ∗state, size_t offset, const void ∗src, size_t length)

    Unpack data.
- void(∗ finish)(void ∗state)

    Finish packing/unpacking.

7.1.1 Detailed Description

This structure provides a generic datatype descriptor that is used for definition of application defined datatypes.

Typically, the descriptor is used for an integration with datatype engines implemented within MPI and SHMEM implementations.

Note

In case of partial receive, any amount of received data is acceptable which matches buffer size.

The documentation for this struct was generated from the following file:

- ucp.h

7.2 uct_tag_context Struct Reference

Posted tag context.

Data Fields

- void(∗ tag_consumed_cb)(uct_tag_context_t ∗self)
- void(∗ completed_cb)(uct_tag_context_t ∗self, uct_tag_t stag, uint64_t imm, size_t length, void ∗inline_data, ucs_status_t status)
- void(∗ rndv_cb)(uct_tag_context_t ∗self, uct_tag_t stag, const void ∗header, unsigned header_length, ucs_status_t status, unsigned flags)
- char priv [UCT_TAG_PRIV_LEN]

7.2.1 Detailed Description

Tag context is an object which tracks a tag posted to the transport. It contains callbacks for matching events on this tag.

7.2.2 Field Documentation

7.2.2.1 tag_consumed_cb

```
void(∗ uct_tag_context::tag_consumed_cb) (uct_tag_context_t ∗self)
```

Tag is consumed by the transport and should not be matched in software.

Parameters

in	*self*	Pointer to relevant context structure, which was initially passed to uct_iface_tag_recv_zcopy.

7.2.2.2 completed_cb

```
void(∗ uct_tag_context::completed_cb) (uct_tag_context_t ∗self, uct_tag_t stag, uint64_t imm,
size_t length, void ∗inline_data, ucs_status_t status)
```

Tag processing is completed by the transport.

Parameters

in	*self*	Pointer to relevant context structure, which was initially passed to uct_iface_tag_recv_zcopy.
in	*stag*	Tag from sender.
in	*imm*	Immediate data from sender. For rendezvous, it's always 0.
in	*length*	Completed length.
in	*inline_data*	If non-null, points to a temporary buffer which contains the received data. In this case the received data was not placed directly in the receive buffer. This callback routine is responsible for copy-out the inline data, otherwise it is released.
in	*status*	Completion status: (a) UCS_OK - Success, data placed in provided buffer. (b) UCS_ERR_TRUNCATED - Sender's length exceed posted buffer, no data is copied. (c) UCS_ERR_CANCELED - Canceled by user.

7.2.2.3 rndv_cb

```
void(* uct_tag_context::rndv_cb) (uct_tag_context_t *self, uct_tag_t stag, const void *header,
unsigned header_length, ucs_status_t status, unsigned flags)
```

Tag was matched by a rendezvous request, which should be completed by the protocol layer.

Parameters

in	*self*	Pointer to relevant context structure, which was initially passed to uct_iface_tag_recv_zcopy.
in	*stag*	Tag from sender.
in	*header*	User defined header.
in	*header_length*	User defined header length in bytes.
in	*status*	Completion status.
in	*flags*	Flags defined by UCT_TAG_RECV_CB_xx.

7.2.2.4 priv

```
char uct_tag_context::priv[UCT_TAG_PRIV_LEN]
```

A placeholder for the private data used by the transport

The documentation for this struct was generated from the following file:

- uct.h

Chapter 8

Example Documentation

8.1 ucp_client_server.c

UCP client / server example using different APIs (tag, stream, am) utility.

```
/*
 * UCP client - server example utility
 * -----------------------------------------------
 *
 * Server side:
 *
 *    ./ucp_client_server
 *
 * Client side:
 *
 *    ./ucp_client_server -a <server-ip>
 *
 * Notes:
 *
 *    - The server will listen to incoming connection requests on INADDR_ANY.
 *    - The client needs to pass the IP address of the server side to connect to
 *      as an argument to the test.
 *    - Currently, the passed IP needs to be an IPoIB or a RoCE address.
 *    - The port which the server side would listen on can be modified with the
 *      '-p' option and should be used on both sides. The default port to use is
 *      13337.
 */

#include "hello_world_util.h"
#include "ucp_util.h"

#include <ucp/api/ucp.h>

#include <string.h>    /* memset */
#include <arpa/inet.h> /* inet_addr */
#include <unistd.h>    /* getopt */
#include <stdlib.h>    /* atoi */

#define DEFAULT_PORT           13337
#define IP_STRING_LEN          50
#define PORT_STRING_LEN        8
#define TAG                    0xCAFE
#define COMM_TYPE_DEFAULT      "STREAM"
#define PRINT_INTERVAL         2000
#define DEFAULT_NUM_ITERATIONS 1
#define TEST_AM_ID             0


static long test_string_length = 16;
static long iov_cnt            = 1;
static uint16_t server_port    = DEFAULT_PORT;
static sa_family_t ai_family   = AF_INET;
static int num_iterations      = DEFAULT_NUM_ITERATIONS;
static int connection_closed   = 1;


typedef enum {
    CLIENT_SERVER_SEND_RECV_STREAM  = UCS_BIT(0),
    CLIENT_SERVER_SEND_RECV_TAG     = UCS_BIT(1),
    CLIENT_SERVER_SEND_RECV_AM      = UCS_BIT(2),
    CLIENT_SERVER_SEND_RECV_DEFAULT = CLIENT_SERVER_SEND_RECV_STREAM
} send_recv_type_t;


typedef struct ucx_server_ctx {
    volatile ucp_conn_request_h conn_request;
    ucp_listener_h              listener;
} ucx_server_ctx_t;


typedef struct test_req {
    int complete;
} test_req_t;


static struct {
    volatile int complete;
    int          is_rndv;
    void         *desc;
    void         *recv_buf;
} am_data_desc = {0, 0, NULL, NULL};


static void usage(void);

void buffer_free(ucp_dt_iov_t *iov)
{
    size_t idx;

    for (idx = 0; idx < iov_cnt; idx++) {
        mem_type_free(iov[idx].buffer);
    }
}

int buffer_malloc(ucp_dt_iov_t *iov)
{
    size_t idx;

    for (idx = 0; idx < iov_cnt; idx++) {
        iov[idx].length = test_string_length;
        iov[idx].buffer = mem_type_malloc(iov[idx].length);
        if (iov[idx].buffer == NULL) {
            buffer_free(iov);
            return -1;
        }
    }

    return 0;
}

int fill_buffer(ucp_dt_iov_t *iov)
{
    int ret = 0;
    size_t idx;

    for (idx = 0; idx < iov_cnt; idx++) {
        ret = generate_test_string(iov[idx].buffer, iov[idx].length);
        if (ret != 0) {
            break;
        }
    }
    CHKERR_ACTION(ret != 0, "generate test string", return -1;);
    return 0;
}

static void common_cb(void *user_data, const char *type_str)
{
    test_req_t *ctx;

    if (user_data == NULL) {
        fprintf(stderr, "user_data passed to %s mustn't be NULL\n", type_str);
        return;
    }

    ctx           = user_data;
    ctx->complete = 1;
}

static void tag_recv_cb(void *request, ucs_status_t status,
                        const ucp_tag_recv_info_t *info, void *user_data)
{
    common_cb(user_data, "tag_recv_cb");
}

static void stream_recv_cb(void *request, ucs_status_t status, size_t length,
                           void *user_data)
{
    common_cb(user_data, "stream_recv_cb");
}

static void am_recv_cb(void *request, ucs_status_t status, size_t length,
                       void *user_data)
{
    common_cb(user_data, "am_recv_cb");
}

static void send_cb(void *request, ucs_status_t status, void *user_data)
{
    common_cb(user_data, "send_cb");
}

static void err_cb(void *arg, ucp_ep_h ep, ucs_status_t status)
{
    printf("error handling callback was invoked with status %d (%s)\n",
           status, ucs_status_string(status));
    connection_closed = 1;
}

void set_sock_addr(const char *address_str, struct sockaddr_storage *saddr)
{
    struct sockaddr_in *sa_in;
    struct sockaddr_in6 *sa_in6;

    /* The server will listen on INADDR_ANY */
    memset(saddr, 0, sizeof(*saddr));

    switch (ai_family) {
    case AF_INET:
        sa_in = (struct sockaddr_in*)saddr;
        if (address_str != NULL) {
            inet_pton(AF_INET, address_str, &sa_in->sin_addr);
        } else {
            sa_in->sin_addr.s_addr = INADDR_ANY;
        }
        sa_in->sin_family = AF_INET;
        sa_in->sin_port   = htons(server_port);
        break;
    case AF_INET6:
        sa_in6 = (struct sockaddr_in6*)saddr;
        if (address_str != NULL) {
            inet_pton(AF_INET6, address_str, &sa_in6->sin6_addr);
        } else {
            sa_in6->sin6_addr = in6addr_any;
        }
        sa_in6->sin6_family = AF_INET6;
        sa_in6->sin6_port   = htons(server_port);
        break;
    default:
        fprintf(stderr, "Invalid address family");
        break;
    }
}

static ucs_status_t start_client(ucp_worker_h ucp_worker,
                                 const char *address_str, ucp_ep_h *client_ep)
{
    ucp_ep_params_t ep_params;
    struct sockaddr_storage connect_addr;
    ucs_status_t status;

    set_sock_addr(address_str, &connect_addr);

    /*
     * Endpoint field mask bits:
     * UCP_EP_PARAM_FIELD_FLAGS             - Use the value of the 'flags' field.
     * UCP_EP_PARAM_FIELD_SOCK_ADDR         - Use a remote sockaddr to connect
     *                                        to the remote peer.
     * UCP_EP_PARAM_FIELD_ERR_HANDLING_MODE - Error handling mode - this flag
     *                                        is temporarily required since the
     *                                        endpoint will be closed with
     *                                        UCP_EP_CLOSE_MODE_FORCE which
     *                                        requires this mode.
     *                                        Once UCP_EP_CLOSE_MODE_FORCE is
     *                                        removed, the error handling mode
     *                                        will be removed.
     */
    ep_params.field_mask       = UCP_EP_PARAM_FIELD_FLAGS       |
                                 UCP_EP_PARAM_FIELD_SOCK_ADDR   |
                                 UCP_EP_PARAM_FIELD_ERR_HANDLER |
                                 UCP_EP_PARAM_FIELD_ERR_HANDLING_MODE;
    ep_params.err_mode         = UCP_ERR_HANDLING_MODE_PEER;
    ep_params.err_handler.cb   = err_cb;
    ep_params.err_handler.arg  = NULL;
    ep_params.flags            = UCP_EP_PARAMS_FLAGS_CLIENT_SERVER;
    ep_params.sockaddr.addr    = (struct sockaddr*)&connect_addr;
    ep_params.sockaddr.addrlen = sizeof(connect_addr);

    status = ucp_ep_create(ucp_worker, &ep_params, client_ep);
    if (status != UCS_OK) {
        fprintf(stderr, "failed to connect to %s (%s)\n", address_str,
                ucs_status_string(status));
    }

    return status;
}

static void print_iov(const ucp_dt_iov_t *iov)
{
    char *msg = alloca(test_string_length);
    size_t idx;

    for (idx = 0; idx < iov_cnt; idx++) {
        /* In case of Non-System memory */
        mem_type_memcpy(msg, iov[idx].buffer, test_string_length);
        printf("%s.\n", msg);
    }
}

static
void print_result(int is_server, const ucp_dt_iov_t *iov, int current_iter)
{
    if (is_server) {
        printf("Server: iteration #%d\n", (current_iter + 1));
        printf("UCX data message was received\n");
        printf("\n\n----- UCP TEST SUCCESS -------\n\n");
    } else {
        printf("Client: iteration #%d\n", (current_iter + 1));
        printf("\n\n------------------------------\n\n");
    }

    print_iov(iov);

    printf("\n\n------------------------------\n\n");
}

static ucs_status_t request_wait(ucp_worker_h ucp_worker, void *request,
                                 test_req_t *ctx)
{
    ucs_status_t status;

    /* if operation was completed immediately */
    if (request == NULL) {
        return UCS_OK;
    }

    if (UCS_PTR_IS_ERR(request)) {
        return UCS_PTR_STATUS(request);
    }

    while (ctx->complete == 0) {
        ucp_worker_progress(ucp_worker);
    }
    status = ucp_request_check_status(request);

    ucp_request_free(request);

    return status;
}

static int request_finalize(ucp_worker_h ucp_worker, test_req_t *request,
                            test_req_t *ctx, int is_server, ucp_dt_iov_t *iov,
                            int current_iter)
{
    int ret = 0;
    ucs_status_t status;

    status = request_wait(ucp_worker, request, ctx);
    if (status != UCS_OK) {
        fprintf(stderr, "unable to %s UCX message (%s)\n",
                is_server ? "receive": "send", ucs_status_string(status));
        ret = -1;
        goto release_iov;
    }

    /* Print the output of the first, last and every PRINT_INTERVAL iteration */
    if ((current_iter == 0) || (current_iter == (num_iterations - 1)) ||
        !((current_iter + 1) % (PRINT_INTERVAL))) {
        print_result(is_server, iov, current_iter);
    }

release_iov:
    buffer_free(iov);
    return ret;
}

static int
fill_request_param(ucp_dt_iov_t *iov, int is_client,
                   void **msg, size_t *msg_length,
                   test_req_t *ctx, ucp_request_param_t *param)
{
    CHKERR_ACTION(buffer_malloc(iov) != 0, "allocate memory", return -1;);

    if (is_client && (fill_buffer(iov) != 0)) {
        buffer_free(iov);
        return -1;
    }

    *msg        = (iov_cnt == 1) ? iov[0].buffer : iov;
    *msg_length = (iov_cnt == 1) ? iov[0].length : iov_cnt;

    ctx->complete       = 0;
    param->op_attr_mask = UCP_OP_ATTR_FIELD_CALLBACK |
                          UCP_OP_ATTR_FIELD_DATATYPE |
                          UCP_OP_ATTR_FIELD_USER_DATA;
    param->datatype     = (iov_cnt == 1) ? ucp_dt_make_contig(1) :
                          UCP_DATATYPE_IOV;
    param->user_data    = ctx;

    return 0;
}

static int send_recv_stream(ucp_worker_h ucp_worker, ucp_ep_h ep, int is_server,
                            int current_iter)
{
    ucp_dt_iov_t *iov = alloca(iov_cnt * sizeof(ucp_dt_iov_t));
    ucp_request_param_t param;
    test_req_t *request;
    size_t msg_length;
    void *msg;
    test_req_t ctx;

    memset(iov, 0, iov_cnt * sizeof(*iov));

    if (fill_request_param(iov, !is_server, &msg, &msg_length,
                           &ctx, &param) != 0) {
        return -1;
    }

    if (!is_server) {
        /* Client sends a message to the server using the stream API */
        param.cb.send = send_cb;
        request       = ucp_stream_send_nbx(ep, msg, msg_length, &param);
    } else {
        /* Server receives a message from the client using the stream API */
        param.op_attr_mask  |= UCP_OP_ATTR_FIELD_FLAGS;
        param.flags          = UCP_STREAM_RECV_FLAG_WAITALL;
        param.cb.recv_stream = stream_recv_cb;
        request              = ucp_stream_recv_nbx(ep, msg, msg_length,
                                                   &msg_length, &param);
    }

    return request_finalize(ucp_worker, request, &ctx, is_server, iov,
                            current_iter);
}

static int send_recv_tag(ucp_worker_h ucp_worker, ucp_ep_h ep, int is_server,
                         int current_iter)
{
    ucp_dt_iov_t *iov = alloca(iov_cnt * sizeof(ucp_dt_iov_t));
    ucp_request_param_t param;
    void *request;
    size_t msg_length;
    void *msg;
    test_req_t ctx;

    memset(iov, 0, iov_cnt * sizeof(*iov));

    if (fill_request_param(iov, !is_server, &msg, &msg_length,
                           &ctx, &param) != 0) {
        return -1;
    }

    if (!is_server) {
        /* Client sends a message to the server using the Tag-Matching API */
        param.cb.send = send_cb;
        request       = ucp_tag_send_nbx(ep, msg, msg_length, TAG, &param);
    } else {
        /* Server receives a message from the client using the Tag-Matching API */
        param.cb.recv = tag_recv_cb;
        request       = ucp_tag_recv_nbx(ucp_worker, msg, msg_length, TAG, 0,
                                         &param);
    }

    return request_finalize(ucp_worker, request, &ctx, is_server, iov,
                            current_iter);
}

ucs_status_t ucp_am_data_cb(void *arg, const void *header, size_t header_length,
                            void *data, size_t length,
                            const ucp_am_recv_param_t *param)
{
    ucp_dt_iov_t *iov;
    size_t idx;
    size_t offset;

    if (length != iov_cnt * test_string_length) {
        fprintf(stderr, "received wrong data length %ld (expected %ld)",
                length, iov_cnt * test_string_length);
        return UCS_OK;
    }

    if (header_length != 0) {
        fprintf(stderr, "received unexpected header, length %ld", header_length);
    }

    am_data_desc.complete++;

    if (param->recv_attr & UCP_AM_RECV_ATTR_FLAG_RNDV) {
        /* Rendezvous request arrived, data contains an internal UCX descriptor,
         * which has to be passed to ucp_am_recv_data_nbx function to confirm
         * data transfer.
         */
        am_data_desc.is_rndv = 1;
        am_data_desc.desc    = data;
        return UCS_INPROGRESS;
    }

    /* Message delivered with eager protocol, data should be available
     * immediately
     */
    am_data_desc.is_rndv = 0;

    iov = am_data_desc.recv_buf;
    offset = 0;
    for (idx = 0; idx < iov_cnt; idx++) {
        mem_type_memcpy(iov[idx].buffer, UCS_PTR_BYTE_OFFSET(data, offset),
                        iov[idx].length);
        offset += iov[idx].length;
    }

    return UCS_OK;
}

static int send_recv_am(ucp_worker_h ucp_worker, ucp_ep_h ep, int is_server,
                        int current_iter)
{
    static int last   = 0;
    ucp_dt_iov_t *iov = alloca(iov_cnt * sizeof(ucp_dt_iov_t));
    test_req_t *request;
    ucp_request_param_t params;
    size_t msg_length;
    void *msg;
    test_req_t ctx;

    memset(iov, 0, iov_cnt * sizeof(*iov));

    if (fill_request_param(iov, !is_server, &msg, &msg_length,
                           &ctx, &params) != 0) {
        return -1;
    }

    if (is_server) {
        am_data_desc.recv_buf = iov;

        /* waiting for AM callback has called */
        while (last == am_data_desc.complete) {
            ucp_worker_progress(ucp_worker);
        }

        last++;

        if (am_data_desc.is_rndv) {
            /* Rendezvous request has arrived, need to invoke receive operation
             * to confirm data transfer from the sender to the "recv_message"
             * buffer. */
            params.op_attr_mask |= UCP_OP_ATTR_FLAG_NO_IMM_CMPL;
            params.cb.recv_am    = am_recv_cb;
            request              = ucp_am_recv_data_nbx(ucp_worker,
                                                        am_data_desc.desc,
                                                        msg, msg_length,
                                                        &params);
        } else {
            /* Data has arrived eagerly and is ready for use, no need to
             * initiate receive operation. */
            request = NULL;
        }
    } else {
        /* Client sends a message to the server using the AM API */
        params.cb.send = (ucp_send_nbx_callback_t)send_cb;
        request        = ucp_am_send_nbx(ep, TEST_AM_ID, NULL, 0ul, msg,
                                         msg_length, &params);
    }

    return request_finalize(ucp_worker, request, &ctx, is_server, iov,
                            current_iter);
}

static void usage()
{
    fprintf(stderr, "Usage: ucp_client_server [parameters]\n");
    fprintf(stderr, "UCP client-server example utility\n");
    fprintf(stderr, "\nParameters are:\n");
    fprintf(stderr, "  -a Set IP address of the server "
                    "(required for client and should not be specified "
                    "for the server)\n");
    fprintf(stderr, "  -l Set IP address where server listens "
                    "(If not specified, server uses INADDR_ANY; "
                    "Irrelevant at client)\n");
    fprintf(stderr, "  -p Port number to listen/connect to (default = %d). "
                    "0 on the server side means select a random port and print it\n",
                    DEFAULT_PORT);
    fprintf(stderr, "  -c Communication type for the client and server. "
                    "  Valid values are:\n"
                    "      'stream' : Stream API\n"
                    "      'tag'    : Tag API\n"
                    "      'am'     : AM API\n"
                    "     If not specified, %s API will be used.\n", COMM_TYPE_DEFAULT);
    fprintf(stderr, "  -i Number of iterations to run. Client and server must "
                    "have the same value. (default = %d).\n",
                    num_iterations);
    fprintf(stderr, "  -v Number of buffers in a single data "
                    "transfer function call. (default = %ld).\n",
                    iov_cnt);
    print_common_help();
    fprintf(stderr, "\n");
}

static int parse_cmd(int argc, char *const argv[], char **server_addr,
                     char **listen_addr, send_recv_type_t *send_recv_type)
{
    int c = 0;
    int port;

    while ((c = getopt(argc, argv, "a:l:p:c:6i:s:v:m:h")) != -1) {
        switch (c) {
        case 'a':
            *server_addr = optarg;
            break;
        case 'c':
            if (!strcasecmp(optarg, "stream")) {
                *send_recv_type = CLIENT_SERVER_SEND_RECV_STREAM;
            } else if (!strcasecmp(optarg, "tag")) {
                *send_recv_type = CLIENT_SERVER_SEND_RECV_TAG;
            } else if (!strcasecmp(optarg, "am")) {
                *send_recv_type = CLIENT_SERVER_SEND_RECV_AM;
            } else {
                fprintf(stderr, "Wrong communication type %s. "
                        "Using %s as default\n", optarg, COMM_TYPE_DEFAULT);
                *send_recv_type = CLIENT_SERVER_SEND_RECV_DEFAULT;
            }
            break;
        case 'l':
            *listen_addr = optarg;
            break;
        case 'p':
            port = atoi(optarg);
            if ((port < 0) || (port > UINT16_MAX)) {
                fprintf(stderr, "Wrong server port number %d\n", port);
                return -1;
            }
            server_port = port;
            break;
        case '6':
            ai_family = AF_INET6;
            break;
        case 'i':
            num_iterations = atoi(optarg);
            break;
        case 's':
            test_string_length = atol(optarg);
            if (test_string_length < 0) {
                fprintf(stderr, "Wrong string size %ld\n", test_string_length);
                return UCS_ERR_UNSUPPORTED;
            }
            break;
        case 'v':
            iov_cnt = atol(optarg);
            if (iov_cnt <= 0) {
                fprintf(stderr, "Wrong iov count %ld\n", iov_cnt);
                return UCS_ERR_UNSUPPORTED;
            }
            break;
        case 'm':
            test_mem_type = parse_mem_type(optarg);
            if (test_mem_type == UCS_MEMORY_TYPE_LAST) {
                return UCS_ERR_UNSUPPORTED;
            }
            break;
        case 'h':
        default:
            usage();
            return -1;
        }
    }

    return 0;
}

static char* sockaddr_get_ip_str(const struct sockaddr_storage *sock_addr,
                                 char *ip_str, size_t max_size)
{
    struct sockaddr_in  addr_in;
    struct sockaddr_in6 addr_in6;

    switch (sock_addr->ss_family) {
    case AF_INET:
        memcpy(&addr_in, sock_addr, sizeof(struct sockaddr_in));
        inet_ntop(AF_INET, &addr_in.sin_addr, ip_str, max_size);
        return ip_str;
    case AF_INET6:
        memcpy(&addr_in6, sock_addr, sizeof(struct sockaddr_in6));
        inet_ntop(AF_INET6, &addr_in6.sin6_addr, ip_str, max_size);
        return ip_str;
    default:
        return "Invalid address family";
    }
}

static char* sockaddr_get_port_str(const struct sockaddr_storage *sock_addr,
                                   char *port_str, size_t max_size)
{
    struct sockaddr_in  addr_in;
    struct sockaddr_in6 addr_in6;

    switch (sock_addr->ss_family) {
    case AF_INET:
        memcpy(&addr_in, sock_addr, sizeof(struct sockaddr_in));
        snprintf(port_str, max_size, "%d", ntohs(addr_in.sin_port));
        return port_str;
    case AF_INET6:
        memcpy(&addr_in6, sock_addr, sizeof(struct sockaddr_in6));
        snprintf(port_str, max_size, "%d", ntohs(addr_in6.sin6_port));
        return port_str;
    default:
        return "Invalid address family";
    }
}

static int client_server_communication(ucp_worker_h worker, ucp_ep_h ep,
                                       send_recv_type_t send_recv_type,
                                       int is_server, int current_iter)
{
    int ret;

    switch (send_recv_type) {
    case CLIENT_SERVER_SEND_RECV_STREAM:
        /* Client-Server communication via Stream API */
        ret = send_recv_stream(worker, ep, is_server, current_iter);
        break;
    case CLIENT_SERVER_SEND_RECV_TAG:
        /* Client-Server communication via Tag-Matching API */
        ret = send_recv_tag(worker, ep, is_server, current_iter);
        break;
    case CLIENT_SERVER_SEND_RECV_AM:
        /* Client-Server communication via AM API. */
        ret = send_recv_am(worker, ep, is_server, current_iter);
        break;
    default:
        fprintf(stderr, "unknown send-recv type %d\n", send_recv_type);
        return -1;
    }

    return ret;
}

static int init_worker(ucp_context_h ucp_context, ucp_worker_h *ucp_worker)
{
    ucp_worker_params_t worker_params;
    ucs_status_t status;
    int ret = 0;

    memset(&worker_params, 0, sizeof(worker_params));

    worker_params.field_mask  = UCP_WORKER_PARAM_FIELD_THREAD_MODE
      ;
    worker_params.thread_mode = UCS_THREAD_MODE_SINGLE;

    status = ucp_worker_create(ucp_context, &worker_params, ucp_worker);
    if (status != UCS_OK) {
        fprintf(stderr, "failed to ucp_worker_create (%s)\n", ucs_status_string(status));
        ret = -1;
    }

    return ret;
}

static void server_conn_handle_cb(ucp_conn_request_h conn_request, void *arg)
{
    ucx_server_ctx_t *context = arg;
    ucp_conn_request_attr_t attr;
    char ip_str[IP_STRING_LEN];
    char port_str[PORT_STRING_LEN];
    ucs_status_t status;

    attr.field_mask = UCP_CONN_REQUEST_ATTR_FIELD_CLIENT_ADDR
      ;
    status = ucp_conn_request_query(conn_request, &attr);
    if (status == UCS_OK) {
        printf("Server received a connection request from client at address %s:%s\n",
               sockaddr_get_ip_str(&attr.client_address, ip_str, sizeof(ip_str)),
               sockaddr_get_port_str(&attr.client_address, port_str, sizeof(port_str)));
    } else if (status != UCS_ERR_UNSUPPORTED) {
        fprintf(stderr, "failed to query the connection request (%s)\n",
                ucs_status_string(status));
    }

    if (context->conn_request == NULL) {
        context->conn_request = conn_request;
    } else {
        /* The server is already handling a connection request from a client,
         * reject this new one */
        printf("Rejecting a connection request. "
               "Only one client at a time is supported.\n");
        status = ucp_listener_reject(context->listener, conn_request);
        if (status != UCS_OK) {
            fprintf(stderr, "server failed to reject a connection request: (%s)\n",
                    ucs_status_string(status));
        }
    }
}

static ucs_status_t server_create_ep(ucp_worker_h data_worker,
                                     ucp_conn_request_h conn_request,
                                     ucp_ep_h *server_ep)
{
    ucp_ep_params_t ep_params;
    ucs_status_t    status;

    /* Server creates an ep to the client on the data worker.
     * This is not the worker the listener was created on.
     * The client side should have initiated the connection, leading
     * to this ep's creation */
    ep_params.field_mask      = UCP_EP_PARAM_FIELD_ERR_HANDLER |
                                UCP_EP_PARAM_FIELD_CONN_REQUEST;
    ep_params.conn_request    = conn_request;
    ep_params.err_handler.cb  = err_cb;
    ep_params.err_handler.arg = NULL;

    status = ucp_ep_create(data_worker, &ep_params, server_ep);
    if (status != UCS_OK) {
        fprintf(stderr, "failed to create an endpoint on the server: (%s)\n",
                ucs_status_string(status));
    }

    return status;
}

static ucs_status_t
start_server(ucp_worker_h ucp_worker, ucx_server_ctx_t *context,
             ucp_listener_h *listener_p, const char *address_str)
{
    struct sockaddr_storage listen_addr;
    ucp_listener_params_t params;
    ucp_listener_attr_t attr;
    ucs_status_t status;
    char ip_str[IP_STRING_LEN];
    char port_str[PORT_STRING_LEN];

    set_sock_addr(address_str, &listen_addr);

    params.field_mask         = UCP_LISTENER_PARAM_FIELD_SOCK_ADDR |
                                UCP_LISTENER_PARAM_FIELD_CONN_HANDLER;
    params.sockaddr.addr      = (const struct sockaddr*)&listen_addr;
    params.sockaddr.addrlen   = sizeof(listen_addr);
    params.conn_handler.cb    = server_conn_handle_cb;
    params.conn_handler.arg   = context;

    /* Create a listener on the server side to listen on the given address.*/
    status = ucp_listener_create(ucp_worker, &params, listener_p);
    if (status != UCS_OK) {
        fprintf(stderr, "failed to listen (%s)\n", ucs_status_string(status));
        goto out;
    }

    /* Query the created listener to get the port it is listening on. */
    attr.field_mask = UCP_LISTENER_ATTR_FIELD_SOCKADDR;
    status = ucp_listener_query(*listener_p, &attr);
    if (status != UCS_OK) {
        fprintf(stderr, "failed to query the listener (%s)\n",
                ucs_status_string(status));
        ucp_listener_destroy(*listener_p);
        goto out;
    }

    fprintf(stderr, "server is listening on IP %s port %s\n",
            sockaddr_get_ip_str(&attr.sockaddr, ip_str, IP_STRING_LEN),
            sockaddr_get_port_str(&attr.sockaddr, port_str, PORT_STRING_LEN));

    printf("Waiting for connection...\n");

out:
    return status;
}

ucs_status_t register_am_recv_callback(ucp_worker_h worker)
{
    ucp_am_handler_param_t param;

    param.field_mask = UCP_AM_HANDLER_PARAM_FIELD_ID |
                       UCP_AM_HANDLER_PARAM_FIELD_CB |
                       UCP_AM_HANDLER_PARAM_FIELD_ARG;
    param.id         = TEST_AM_ID;
    param.cb         = ucp_am_data_cb;
    param.arg        = worker; /* not used in our callback */

    return ucp_worker_set_am_recv_handler(worker, &param);
}

static int client_server_do_work(ucp_worker_h ucp_worker, ucp_ep_h ep,
                                 send_recv_type_t send_recv_type, int is_server)
{
    int i, ret = 0;
    ucs_status_t status;

    connection_closed = 0;

    for (i = 0; i < num_iterations; i++) {
        ret = client_server_communication(ucp_worker, ep, send_recv_type,
                                          is_server, i);
        if (ret != 0) {
            fprintf(stderr, "%s failed on iteration #%d\n",
                    (is_server ? "server": "client"), i + 1);
            goto out;
        }
    }

    /* Register recv callback on the client side to receive FIN message */
    if (!is_server && (send_recv_type == CLIENT_SERVER_SEND_RECV_AM)) {
        status = register_am_recv_callback(ucp_worker);
        if (status != UCS_OK) {
            ret = -1;
            goto out;
        }
    }

    /* FIN message in reverse direction to acknowledge delivery */
    ret = client_server_communication(ucp_worker, ep, send_recv_type,
                                      !is_server, i + 1);
    if (ret != 0) {
        fprintf(stderr, "%s failed on FIN message\n",
                (is_server ? "server": "client"));
        goto out;
    }

    printf("%s FIN message\n", is_server ? "sent" : "received");

    /* Server waits until the client closed the connection after receiving FIN */
    while (is_server && !connection_closed) {
        ucp_worker_progress(ucp_worker);
    }

out:
    return ret;
}

static int run_server(ucp_context_h ucp_context, ucp_worker_h ucp_worker,
                      char *listen_addr, send_recv_type_t send_recv_type)
{
    ucx_server_ctx_t context;
    ucp_worker_h     ucp_data_worker;
    ucp_ep_h         server_ep;
    ucs_status_t     status;
    int              ret;

    /* Create a data worker (to be used for data exchange between the server
     * and the client after the connection between them was established) */
    ret = init_worker(ucp_context, &ucp_data_worker);
    if (ret != 0) {
        goto err;
    }

    if (send_recv_type == CLIENT_SERVER_SEND_RECV_AM) {
        status = register_am_recv_callback(ucp_data_worker);
        if (status != UCS_OK) {
            ret = -1;
            goto err_worker;
        }
    }

    /* Initialize the server's context. */
    context.conn_request = NULL;

    /* Create a listener on the worker created at first. The 'connection
     * worker' - used for connection establishment between client and server.
     * This listener will stay open for listening to incoming connection
     * requests from the client */
    status = start_server(ucp_worker, &context, &context.listener, listen_addr);
    if (status != UCS_OK) {
        ret = -1;
        goto err_worker;
    }

    /* Server is always up listening */
    while (1) {
        /* Wait for the server to receive a connection request from the client.
         * If there are multiple clients for which the server's connection request
         * callback is invoked, i.e. several clients are trying to connect in
         * parallel, the server will handle only the first one and reject the rest */
        while (context.conn_request == NULL) {
            ucp_worker_progress(ucp_worker);
        }

        /* Server creates an ep to the client on the data worker.
         * This is not the worker the listener was created on.
         * The client side should have initiated the connection, leading
         * to this ep's creation */
        status = server_create_ep(ucp_data_worker, context.conn_request,
                                  &server_ep);
        if (status != UCS_OK) {
            ret = -1;
            goto err_listener;
        }

        /* The server waits for all the iterations to complete before moving on
         * to the next client */
        ret = client_server_do_work(ucp_data_worker, server_ep, send_recv_type,
                                    1);
        if (ret != 0) {
            goto err_ep;
        }

        /* Close the endpoint to the client */
        ep_close(ucp_data_worker, server_ep, UCP_EP_CLOSE_FLAG_FORCE);

        /* Reinitialize the server's context to be used for the next client */
        context.conn_request = NULL;

        printf("Waiting for connection...\n");
    }

err_ep:
    ep_close(ucp_data_worker, server_ep, UCP_EP_CLOSE_FLAG_FORCE);
err_listener:
    ucp_listener_destroy(context.listener);
err_worker:
    ucp_worker_destroy(ucp_data_worker);
err:
    return ret;
}

static int run_client(ucp_worker_h ucp_worker, char *server_addr,
                      send_recv_type_t send_recv_type)
{
    ucp_ep_h     client_ep;
    ucs_status_t status;
    int          ret;

    status = start_client(ucp_worker, server_addr, &client_ep);
    if (status != UCS_OK) {
        fprintf(stderr, "failed to start client (%s)\n", ucs_status_string(status));
        ret = -1;
        goto out;
    }

    ret = client_server_do_work(ucp_worker, client_ep, send_recv_type, 0);

    /* Close the endpoint to the server */
    ep_close(ucp_worker, client_ep, UCP_EP_CLOSE_FLAG_FORCE);

out:
    return ret;
}

static int init_context(ucp_context_h *ucp_context, ucp_worker_h *ucp_worker,
                        send_recv_type_t send_recv_type)
{
    /* UCP objects */
    ucp_params_t ucp_params;
    ucs_status_t status;
    int ret = 0;

    memset(&ucp_params, 0, sizeof(ucp_params));

    /* UCP initialization */
    ucp_params.field_mask = UCP_PARAM_FIELD_FEATURES |
      UCP_PARAM_FIELD_NAME;
    ucp_params.name       = "client_server";

    if (send_recv_type == CLIENT_SERVER_SEND_RECV_STREAM) {
        ucp_params.features = UCP_FEATURE_STREAM;
    } else if (send_recv_type == CLIENT_SERVER_SEND_RECV_TAG) {
        ucp_params.features = UCP_FEATURE_TAG;
    } else {
        ucp_params.features = UCP_FEATURE_AM;
    }

    status = ucp_init(&ucp_params, NULL, ucp_context);
    if (status != UCS_OK) {
        fprintf(stderr, "failed to ucp_init (%s)\n", ucs_status_string(status));
        ret = -1;
        goto err;
    }

    ret = init_worker(*ucp_context, ucp_worker);
    if (ret != 0) {
        goto err_cleanup;
    }
    return ret;

err_cleanup:
    ucp_cleanup(*ucp_context);
err:
    return ret;
}


int main(int argc, char **argv)
{
    send_recv_type_t send_recv_type = CLIENT_SERVER_SEND_RECV_DEFAULT;
    char *server_addr = NULL;
    char *listen_addr = NULL;
    int ret;

    /* UCP objects */
    ucp_context_h ucp_context;
    ucp_worker_h  ucp_worker;

    ret = parse_cmd(argc, argv, &server_addr, &listen_addr, &send_recv_type);
    if (ret != 0) {
        goto err;
    }

    /* Initialize the UCX required objects */
    ret = init_context(&ucp_context, &ucp_worker, send_recv_type);
    if (ret != 0) {
        goto err;
    }

    /* Client-Server initialization */
    if (server_addr == NULL) {
        /* Server side */
        ret = run_server(ucp_context, ucp_worker, listen_addr, send_recv_type);
    } else {
        /* Client side */
        ret = run_client(ucp_worker, server_addr, send_recv_type);
    }

    ucp_worker_destroy(ucp_worker);
    ucp_cleanup(ucp_context);
err:
    return ret;
}
```

8.2 ucp_hello_world.c

UCP hello world client / server example utility.

```
#ifndef HAVE_CONFIG_H
#  define HAVE_CONFIG_H /* Force using config.h, so test would fail if header
                           actually tries to use it */
#endif

/*
 * UCP hello world client / server example utility
 * -----------------------------------------------
 *
 * Server side:
 *
 *    ./ucp_hello_world
 *
 * Client side:
 *
 *    ./ucp_hello_world -n <server host name>
 *
 * Notes:
 *
 *    - Client acquires Server UCX address via TCP socket
 *
 *
 * Author:
 *
 *    Ilya Nelkenbaum <ilya@nelkenbaum.com>
 *    Sergey Shalnov <sergeysh@mellanox.com> 7-June-2016
 */

#include "hello_world_util.h"
#include "ucp_util.h"
```

```
#include <ucp/api/ucp.h>

#include <sys/socket.h>
#include <sys/types.h>
#include <sys/epoll.h>
#include <netinet/in.h>
#include <assert.h>
#include <netdb.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <unistd.h>  /* getopt */
#include <pthread.h> /* pthread_self */
#include <errno.h>   /* errno */
#include <time.h>
#include <signal.h>  /* raise */

struct msg {
    uint64_t        data_len;
};

struct ucx_context {
    int             completed;
};

enum ucp_test_mode_t {
    TEST_MODE_PROBE,
    TEST_MODE_WAIT,
    TEST_MODE_EVENTFD
} ucp_test_mode = TEST_MODE_PROBE;

typedef enum {
    FAILURE_MODE_NONE,
    FAILURE_MODE_SEND,      /* fail send operation on server */
    FAILURE_MODE_RECV,      /* fail receive operation on client */
    FAILURE_MODE_KEEPALIVE  /* fail without communication on client */
} failure_mode_t;

static struct err_handling {
    ucp_err_handling_mode_t ucp_err_mode;
    failure_mode_t          failure_mode;
} err_handling_opt;

static ucs_status_t ep_status   = UCS_OK;
static uint16_t server_port     = 13337;
static sa_family_t ai_family    = AF_INET;
static long test_string_length  = 16;
static const ucp_tag_t tag      = 0x1337a880u;
static const ucp_tag_t tag_mask = UINT64_MAX;
static const char *addr_msg_str = "UCX address message";
static const char *data_msg_str = "UCX data message";
static int print_config         = 0;

static ucs_status_t parse_cmd(int argc, char * const argv[], char **server_name);

static void set_msg_data_len(struct msg *msg, uint64_t data_len)
{
    mem_type_memcpy(&msg->data_len, &data_len, sizeof(data_len));
}

static void request_init(void *request)
{
    struct ucx_context *context = (struct ucx_context *)request;

    context->completed = 0;
}

static void send_handler(void *request, ucs_status_t status, void *ctx)
{
    struct ucx_context *context = (struct ucx_context *)request;
    const char *str             = (const char *)ctx;

    context->completed = 1;

    printf("[0x%x] send handler called for \"%s\" with status %d (%s)\n",
           (unsigned int)pthread_self(), str, status,
           ucs_status_string(status));
}

static void failure_handler(void *arg, ucp_ep_h ep, ucs_status_t status)
{
    ucs_status_t *arg_status = (ucs_status_t *)arg;

    printf("[0x%x] failure handler called with status %d (%s)\n",
           (unsigned int)pthread_self(), status, ucs_status_string(status));
    *arg_status = status;
}

static void recv_handler(void *request, ucs_status_t status,
                         const ucp_tag_recv_info_t *info, void *user_data)
{
    struct ucx_context *context = (struct ucx_context *)request;

    context->completed = 1;

    printf("[0x%x] receive handler called with status %d (%s), length %lu\n",
           (unsigned int)pthread_self(), status, ucs_status_string(status),
           info->length);
}

static ucs_status_t ucx_wait(ucp_worker_h ucp_worker, struct ucx_context *request,
                             const char *op_str, const char *data_str)
{
    ucs_status_t status;

    if (UCS_PTR_IS_ERR(request)) {
        status = UCS_PTR_STATUS(request);
    } else if (UCS_PTR_IS_PTR(request)) {
        while (!request->completed) {
            ucp_worker_progress(ucp_worker);
        }

        request->completed = 0;
        status             = ucp_request_check_status(request);
        ucp_request_free(request);
    } else {
        status = UCS_OK;
    }

    if (status != UCS_OK) {
        fprintf(stderr, "unable to %s %s (%s)\n", op_str, data_str,
                ucs_status_string(status));
    } else {
        printf("finish to %s %s\n", op_str, data_str);
    }

    return status;
}

static ucs_status_t test_poll_wait(ucp_worker_h ucp_worker)
{
    int err            = 0;
    ucs_status_t ret   = UCS_ERR_NO_MESSAGE;
    int epoll_fd_local = 0;
    int epoll_fd       = 0;
    ucs_status_t status;
    struct epoll_event ev;
    ev.data.u64        = 0;

    status = ucp_worker_get_efd(ucp_worker, &epoll_fd);
    CHKERR_JUMP(UCS_OK != status, "ucp_worker_get_efd", err);

    /* It is recommended to copy original fd */
    epoll_fd_local = epoll_create(1);

    ev.data.fd = epoll_fd;
    ev.events = EPOLLIN;
    err = epoll_ctl(epoll_fd_local, EPOLL_CTL_ADD, epoll_fd, &ev);
    CHKERR_JUMP(err < 0, "add original socket to the new epoll\n", err_fd);

    /* Need to prepare ucp_worker before epoll_wait */
    status = ucp_worker_arm(ucp_worker);
    if (status == UCS_ERR_BUSY) { /* some events are arrived already */
        ret = UCS_OK;
        goto err_fd;
    }
    CHKERR_JUMP(status != UCS_OK, "ucp_worker_arm\n", err_fd);

    do {
        err = epoll_wait(epoll_fd_local, &ev, 1, -1);
    } while ((err == -1) && (errno == EINTR));

    ret = UCS_OK;

err_fd:
    close(epoll_fd_local);

err:
    return ret;
}

static void ep_close_err_mode(ucp_worker_h ucp_worker, ucp_ep_h ucp_ep)
```

```
{
    uint64_t ep_close_flags;

    if (err_handling_opt.ucp_err_mode == UCP_ERR_HANDLING_MODE_PEER) {
        ep_close_flags = UCP_EP_CLOSE_FLAG_FORCE;
    } else {
        ep_close_flags = 0;
    }

    ep_close(ucp_worker, ucp_ep, ep_close_flags);
}

static int run_ucx_client(ucp_worker_h ucp_worker,
                          ucp_address_t *local_addr, size_t local_addr_len,
                          ucp_address_t *peer_addr, size_t peer_addr_len)
{
    struct msg *msg = NULL;
    size_t msg_len  = 0;
    int ret         = -1;
    ucp_request_param_t send_param, recv_param;
    ucp_tag_recv_info_t info_tag;
    ucp_tag_message_h msg_tag;
    ucs_status_t status;
    ucp_ep_h server_ep;
    ucp_ep_params_t ep_params;
    struct ucx_context *request;
    char *str;

    /* Send client UCX address to server */
    ep_params.field_mask      = UCP_EP_PARAM_FIELD_REMOTE_ADDRESS
       |
                                UCP_EP_PARAM_FIELD_ERR_HANDLING_MODE |
                                UCP_EP_PARAM_FIELD_ERR_HANDLER |
                                UCP_EP_PARAM_FIELD_USER_DATA;
    ep_params.address         = peer_addr;
    ep_params.err_mode        = err_handling_opt.ucp_err_mode;
    ep_params.err_handler.cb  = failure_handler;
    ep_params.err_handler.arg = NULL;
    ep_params.user_data       = &ep_status;

    status = ucp_ep_create(ucp_worker, &ep_params, &server_ep);
    CHKERR_JUMP(status != UCS_OK, "ucp_ep_create\n", err);

    msg_len = sizeof(*msg) + local_addr_len;
    msg     = malloc(msg_len);
    CHKERR_JUMP(msg == NULL, "allocate memory\n", err_ep);
    memset(msg, 0, msg_len);

    msg->data_len = local_addr_len;
    memcpy(msg + 1, local_addr, local_addr_len);

    send_param.op_attr_mask = UCP_OP_ATTR_FIELD_CALLBACK |
                              UCP_OP_ATTR_FIELD_USER_DATA;
    send_param.cb.send      = send_handler;
    send_param.user_data    = (void*)addr_msg_str;
    request                 = ucp_tag_send_nbx(server_ep, msg, msg_len, tag,
                                               &send_param);
    status                  = ucx_wait(ucp_worker, request, "send",
                                       addr_msg_str);
    if (status != UCS_OK) {
        free(msg);
        goto err_ep;
    }

    free(msg);

    if (err_handling_opt.failure_mode == FAILURE_MODE_RECV) {
        fprintf(stderr, "Emulating failure before receive operation on client side\n");
        raise(SIGKILL);
    }

    /* Receive test string from server */
    for (;;) {
        CHKERR_JUMP(ep_status != UCS_OK, "receive data: EP disconnected\n", err_ep);
        /* Probing incoming events in non-block mode */
        msg_tag = ucp_tag_probe_nb(ucp_worker, tag, tag_mask, 1, &info_tag);
        if (msg_tag != NULL) {
            /* Message arrived */
            break;
        } else if (ucp_worker_progress(ucp_worker)) {
            /* Some events were polled; try again without going to sleep */
            continue;
        }

        /* If we got here, ucp_worker_progress() returned 0, so we can sleep.
         * Following blocked methods used to polling internal file descriptor
         * to make CPU idle and don't spin loop
         */
        if (ucp_test_mode == TEST_MODE_WAIT) {
            /* Polling incoming events*/
            status = ucp_worker_wait(ucp_worker);
            CHKERR_JUMP(status != UCS_OK, "ucp_worker_wait\n", err_ep);
        } else if (ucp_test_mode == TEST_MODE_EVENTFD) {
            status = test_poll_wait(ucp_worker);
            CHKERR_JUMP(status != UCS_OK, "test_poll_wait\n", err_ep);
        }
    }

    if (err_handling_opt.failure_mode == FAILURE_MODE_KEEPALIVE) {
        fprintf(stderr, "Emulating unexpected failure after receive completion "
                        "on client side, server should detect error by "
                        "keepalive mechanism\n");
        raise(SIGKILL);
    }

    msg = mem_type_malloc(info_tag.length);
    CHKERR_JUMP(msg == NULL, "allocate memory\n", err_ep);

    recv_param.op_attr_mask = UCP_OP_ATTR_FIELD_CALLBACK |
                              UCP_OP_ATTR_FIELD_DATATYPE |
                              UCP_OP_ATTR_FLAG_NO_IMM_CMPL;
    recv_param.datatype     = ucp_dt_make_contig(1);
    recv_param.cb.recv      = recv_handler;

    request = ucp_tag_msg_recv_nbx(ucp_worker, msg, info_tag.
      length, msg_tag,
                                   &recv_param);

    status  = ucx_wait(ucp_worker, request, "receive", data_msg_str);
    if (status != UCS_OK) {
        mem_type_free(msg);
        goto err_ep;
    }

    str = calloc(1, test_string_length);
    if (str == NULL) {
        fprintf(stderr, "Memory allocation failed\n");
        ret = -1;
        goto err_msg;
    }

    mem_type_memcpy(str, msg + 1, test_string_length);
    printf("\n\n----- UCP TEST SUCCESS ----\n\n");
    printf("%s", str);
    printf("\n\n----------------------------\n\n");
    free(str);
    ret = 0;

err_msg:
    mem_type_free(msg);
err_ep:
    ep_close_err_mode(ucp_worker, server_ep);
err:
    return ret;
}

static ucs_status_t flush_ep(ucp_worker_h worker,
      ucp_ep_h ep)
{
    ucp_request_param_t param;
    void *request;

    param.op_attr_mask = 0;
    request            = ucp_ep_flush_nbx(ep, &param);
    if (request == NULL) {
        return UCS_OK;
    } else if (UCS_PTR_IS_ERR(request)) {
        return UCS_PTR_STATUS(request);
    } else {
        ucs_status_t status;
        do {
            ucp_worker_progress(worker);
            status = ucp_request_check_status(request);
        } while (status == UCS_INPROGRESS);
        ucp_request_free(request);
        return status;
    }
}

static int run_ucx_server(ucp_worker_h ucp_worker)
{
    struct msg *msg              = NULL;
    struct ucx_context *request = NULL;
    size_t msg_len               = 0;
```

```
ucp_request_param_t send_param, recv_param;
ucp_tag_recv_info_t info_tag;
ucp_tag_message_h msg_tag;
ucs_status_t status;
ucp_ep_h client_ep;
ucp_ep_params_t ep_params;
ucp_address_t *peer_addr;
size_t peer_addr_len;

int ret;

/* Receive client UCX address */
do {
    /* Progressing before probe to update the state */
    ucp_worker_progress(ucp_worker);

    /* Probing incoming events in non-block mode */
    msg_tag = ucp_tag_probe_nb(ucp_worker, tag, tag_mask, 1, &info_tag);
} while (msg_tag == NULL);

msg = malloc(info_tag.length);
CHKERR_ACTION(msg == NULL, "allocate memory\n", ret = -1; goto err);

recv_param.op_attr_mask = UCP_OP_ATTR_FIELD_CALLBACK |
                          UCP_OP_ATTR_FIELD_DATATYPE |
                          UCP_OP_ATTR_FLAG_NO_IMM_CMPL;
recv_param.datatype     = ucp_dt_make_contig(1);
recv_param.cb.recv      = recv_handler;

request = ucp_tag_msg_recv_nbx(ucp_worker, msg, info_tag.
  length,
                                msg_tag, &recv_param);

status  = ucx_wait(ucp_worker, request, "receive", addr_msg_str);
if (status != UCS_OK) {
    free(msg);
    ret = -1;
    goto err;
}

if (err_handling_opt.failure_mode == FAILURE_MODE_SEND) {
    fprintf(stderr, "Emulating unexpected failure on server side, client "
                    "should detect error by keepalive mechanism\n");
    free(msg);
    raise(SIGKILL);
    exit(1);
}

peer_addr_len = msg->data_len;
peer_addr     = malloc(peer_addr_len);
if (peer_addr == NULL) {
    fprintf(stderr, "unable to allocate memory for peer address\n");
    free(msg);
    ret = -1;
    goto err;
}

memcpy(peer_addr, msg + 1, peer_addr_len);

free(msg);

/* Send test string to client */
ep_params.field_mask      = UCP_EP_PARAM_FIELD_REMOTE_ADDRESS
   |
                            UCP_EP_PARAM_FIELD_ERR_HANDLING_MODE |
                            UCP_EP_PARAM_FIELD_ERR_HANDLER |
                            UCP_EP_PARAM_FIELD_USER_DATA;
ep_params.address         = peer_addr;
ep_params.err_mode        = err_handling_opt.ucp_err_mode;
ep_params.err_handler.cb  = failure_handler;
ep_params.err_handler.arg = NULL;
ep_params.user_data       = &ep_status;

status = ucp_ep_create(ucp_worker, &ep_params, &client_ep);
/* If peer failure testing was requested, it could be possible that UCP EP
 * couldn't be created; in this case set `ret = 0` to report success */
ret = (err_handling_opt.failure_mode != FAILURE_MODE_NONE) ? 0 : -1;
CHKERR_ACTION(status != UCS_OK, "ucp_ep_create\n", goto err);

msg_len = sizeof(*msg) + test_string_length;
msg = mem_type_malloc(msg_len);
CHKERR_ACTION(msg == NULL, "allocate memory\n", ret = -1; goto err_ep);
mem_type_memset(msg, 0, msg_len);

set_msg_data_len(msg, msg_len - sizeof(*msg));
ret = generate_test_string((char *)(msg + 1), test_string_length);
CHKERR_JUMP(ret < 0, "generate test string", err_free_mem_type_msg);
```

```
    if (err_handling_opt.failure_mode == FAILURE_MODE_RECV) {
        /* Sleep for small amount of time to ensure that client was killed
         * and peer failure handling is covered */
        sleep(5);
    }

    ucp_worker_progress(ucp_worker);

    send_param.op_attr_mask = UCP_OP_ATTR_FIELD_CALLBACK  |
                              UCP_OP_ATTR_FIELD_USER_DATA |
                              UCP_OP_ATTR_FIELD_MEMORY_TYPE;
    send_param.cb.send      = send_handler;
    send_param.user_data    = (void*)data_msg_str;
    send_param.memory_type  = test_mem_type;
    request                 = ucp_tag_send_nbx(client_ep, msg, msg_len, tag,
                                               &send_param);
    status                  = ucx_wait(ucp_worker, request, "send",
                                       data_msg_str);
    if (status != UCS_OK) {
        if (err_handling_opt.failure_mode != FAILURE_MODE_NONE) {
            ret = -1;
        } else {
            /* If peer failure testing was requested, set `ret = 0` to report
             * success from the application */
            ret = 0;

            /* Make sure that failure_handler was called */
            while (ep_status == UCS_OK) {
                ucp_worker_progress(ucp_worker);
            }
        }
        goto err_free_mem_type_msg;
    }

    if (err_handling_opt.failure_mode == FAILURE_MODE_KEEPALIVE) {
        fprintf(stderr, "Waiting for client is terminated\n");
        while (ep_status == UCS_OK) {
            ucp_worker_progress(ucp_worker);
        }
    }

    status = flush_ep(ucp_worker, client_ep);
    printf("flush_ep completed with status %d (%s)\n",
           status, ucs_status_string(status));

    ret = 0;

err_free_mem_type_msg:
    mem_type_free(msg);
err_ep:
    ep_close_err_mode(ucp_worker, client_ep);
err:
    return ret;
}

static void progress_worker(void *arg)
{
    ucp_worker_progress((ucp_worker_h)arg);
}

int main(int argc, char **argv)
{
    /* UCP temporary vars */
    ucp_params_t ucp_params;
    ucp_worker_attr_t worker_attr;
    ucp_worker_params_t worker_params;
    ucp_config_t *config;
    ucs_status_t status;

    /* UCP handler objects */
    ucp_context_h ucp_context;
    ucp_worker_h ucp_worker;

    /* OOB connection vars */
    uint64_t local_addr_len   = 0;
    ucp_address_t *local_addr = NULL;
    uint64_t peer_addr_len    = 0;
    ucp_address_t *peer_addr  = NULL;
    char *client_target_name  = NULL;
    int oob_sock              = -1;
    int ret                   = -1;

    memset(&ucp_params, 0, sizeof(ucp_params));
    memset(&worker_attr, 0, sizeof(worker_attr));
    memset(&worker_params, 0, sizeof(worker_params));
    /* Parse the command line */
    status = parse_cmd(argc, argv, &client_target_name);
    CHKERR_JUMP(status != UCS_OK, "parse_cmd\n", err);

    /* UCP initialization */
    status = ucp_config_read(NULL, NULL, &config);
    CHKERR_JUMP(status != UCS_OK, "ucp_config_read\n", err);

    ucp_params.field_mask   = UCP_PARAM_FIELD_FEATURES |
                              UCP_PARAM_FIELD_REQUEST_SIZE |
                              UCP_PARAM_FIELD_REQUEST_INIT |
                              UCP_PARAM_FIELD_NAME;
    ucp_params.features     = UCP_FEATURE_TAG;
    if (ucp_test_mode == TEST_MODE_WAIT || ucp_test_mode == TEST_MODE_EVENTFD) {
        ucp_params.features |= UCP_FEATURE_WAKEUP;
    }
    ucp_params.request_size    = sizeof(struct ucx_context);
    ucp_params.request_init    = request_init;
    ucp_params.name            = "hello_world";

    status = ucp_init(&ucp_params, config, &ucp_context);

    if (print_config) {
        ucp_config_print(config, stdout, NULL, UCS_CONFIG_PRINT_CONFIG);
    }

    ucp_config_release(config);
    CHKERR_JUMP(status != UCS_OK, "ucp_init\n", err);

    worker_params.field_mask  = UCP_WORKER_PARAM_FIELD_THREAD_MODE
      ;
    worker_params.thread_mode = UCS_THREAD_MODE_SINGLE;

    status = ucp_worker_create(ucp_context, &worker_params, &ucp_worker);
    CHKERR_JUMP(status != UCS_OK, "ucp_worker_create\n", err_cleanup);

    worker_attr.field_mask = UCP_WORKER_ATTR_FIELD_ADDRESS;

    status = ucp_worker_query(ucp_worker, &worker_attr);
    CHKERR_JUMP(status != UCS_OK, "ucp_worker_query\n", err_worker);
    local_addr_len = worker_attr.address_length;
    local_addr     = worker_attr.address;

    printf("[0x%x] local address length: %lu\n",
           (unsigned int)pthread_self(), local_addr_len);

    /* OOB connection establishment */
    if (client_target_name != NULL) {
        oob_sock = connect_common(client_target_name, server_port, ai_family);
        CHKERR_JUMP(oob_sock < 0, "client_connect\n", err_addr);

        ret = recv(oob_sock, &peer_addr_len, sizeof(peer_addr_len), MSG_WAITALL);
        CHKERR_JUMP_RETVAL(ret != (int)sizeof(peer_addr_len),
                           "receive address length\n", err_addr, ret);

        peer_addr = malloc(peer_addr_len);
        CHKERR_JUMP(!peer_addr, "allocate memory\n", err_addr);

        ret = recv(oob_sock, peer_addr, peer_addr_len, MSG_WAITALL);
        CHKERR_JUMP_RETVAL(ret != (int)peer_addr_len,
                           "receive address\n", err_peer_addr, ret);
    } else {
        oob_sock = connect_common(NULL, server_port, ai_family);
        CHKERR_JUMP(oob_sock < 0, "server_connect\n", err_peer_addr);

        ret = send(oob_sock, &local_addr_len, sizeof(local_addr_len), 0);
        CHKERR_JUMP_RETVAL(ret != (int)sizeof(local_addr_len),
                           "send address length\n", err_peer_addr, ret);

        ret = send(oob_sock, local_addr, local_addr_len, 0);
        CHKERR_JUMP_RETVAL(ret != (int)local_addr_len, "send address\n",
                           err_peer_addr, ret);
    }

    if (client_target_name != NULL) {
        ret = run_ucx_client(ucp_worker,
                             local_addr, local_addr_len,
                             peer_addr, peer_addr_len);
    } else {
        ret = run_ucx_server(ucp_worker);
    }

    if (!ret && (err_handling_opt.failure_mode == FAILURE_MODE_NONE)) {
        /* Make sure remote is disconnected before destroying local worker */
        ret = barrier(oob_sock, progress_worker, ucp_worker);
    }
    close(oob_sock);
```

```
err_peer_addr:
    free(peer_addr);

err_addr:
    ucp_worker_release_address(ucp_worker, local_addr);

err_worker:
    ucp_worker_destroy(ucp_worker);

err_cleanup:
    ucp_cleanup(ucp_context);

err:
    return ret;
}

static void print_usage()
{
    fprintf(stderr, "Usage: ucp_hello_world [parameters]\n");
    fprintf(stderr, "UCP hello world client/server example utility\n");
    fprintf(stderr, "\nParameters are:\n");
    fprintf(stderr, "  -w      Select test mode \"wait\" to test "
            "ucp_worker_wait function\n");
    fprintf(stderr, "  -f      Select test mode \"event fd\" to test "
            "ucp_worker_get_efd function with later poll\n");
    fprintf(stderr, "  -b      Select test mode \"busy polling\" to test "
            "ucp_tag_probe_nb and ucp_worker_progress (default)\n");
    fprintf(stderr, "  -n <name> Set node name or IP address "
            "of the server (required for client and should be ignored "
            "for server)\n");
    fprintf(stderr, "  -e <type> Emulate unexpected failure and handle an "
                                "error with enabled UCP_ERR_HANDLING_MODE_PEER\n");
    fprintf(stderr, "             send      - send failure on server side "
                                "before send initiated\n");
    fprintf(stderr, "             recv      - receive failure on client side "
                                "before receive completed\n");
    fprintf(stderr, "             keepalive - keepalive failure on client side "
                                "after communication completed\n");
    fprintf(stderr, "  -c      Print UCP configuration\n");
    print_common_help();
    fprintf(stderr, "\n");
}

ucs_status_t parse_cmd(int argc, char * const argv[], char **server_name)
{
    int c = 0, idx = 0;

    err_handling_opt.ucp_err_mode = UCP_ERR_HANDLING_MODE_NONE;
    err_handling_opt.failure_mode = FAILURE_MODE_NONE;

    while ((c = getopt(argc, argv, "wfb6e:n:p:s:m:ch")) != -1) {
        switch (c) {
        case 'w':
            ucp_test_mode = TEST_MODE_WAIT;
            break;
        case 'f':
            ucp_test_mode = TEST_MODE_EVENTFD;
            break;
        case 'b':
            ucp_test_mode = TEST_MODE_PROBE;
            break;
        case 'e':
            err_handling_opt.ucp_err_mode = UCP_ERR_HANDLING_MODE_PEER;
            if (!strcmp(optarg, "recv")) {
                err_handling_opt.failure_mode = FAILURE_MODE_RECV;
            } else if (!strcmp(optarg, "send")) {
                err_handling_opt.failure_mode = FAILURE_MODE_SEND;
            } else if (!strcmp(optarg, "keepalive")) {
                err_handling_opt.failure_mode = FAILURE_MODE_KEEPALIVE;
            } else {
                print_usage();
                return UCS_ERR_UNSUPPORTED;
            }
            break;
        case 'n':
            *server_name = optarg;
            break;
        case '6':
            ai_family = AF_INET6;
            break;
        case 'p':
            server_port = atoi(optarg);
            if (server_port <= 0) {
                fprintf(stderr, "Wrong server port number %d\n", server_port);
                return UCS_ERR_UNSUPPORTED;
            }
            break;
        case 's':
            test_string_length = atol(optarg);
            if (test_string_length < 0) {
                fprintf(stderr, "Wrong string size %ld\n", test_string_length);
                return UCS_ERR_UNSUPPORTED;
            }
            break;
        case 'm':
            test_mem_type = parse_mem_type(optarg);
            if (test_mem_type == UCS_MEMORY_TYPE_LAST) {
                return UCS_ERR_UNSUPPORTED;
            }
            break;
        case 'c':
            print_config = 1;
            break;
        case 'h':
        default:
            print_usage();
            return UCS_ERR_UNSUPPORTED;
        }
    }
    fprintf(stderr, "INFO: UCP_HELLO_WORLD mode = %d server = %s port = %d, pid = %d\n",
            ucp_test_mode, *server_name, server_port, getpid());

    for (idx = optind; idx < argc; idx++) {
        fprintf(stderr, "WARNING: Non-option argument %s\n", argv[idx]);
    }
    return UCS_OK;
}
```

8.3 uct_hello_world.c

UCT hello world client / server example utility.

```
#include "hello_world_util.h"
#include <limits.h>

#include <uct/api/uct.h>

#include <assert.h>
#include <inttypes.h>


typedef enum {
    FUNC_AM_SHORT,
    FUNC_AM_BCOPY,
    FUNC_AM_ZCOPY
} func_am_t;

typedef struct {
    int  is_uct_desc;
} recv_desc_t;

typedef struct {
    char                *server_name;
    uint16_t             server_port;
    sa_family_t          ai_family;
    func_am_t            func_am_type;
    const char          *dev_name;
    const char          *tl_name;
    long                 test_strlen;
} cmd_args_t;

typedef struct {
    uct_iface_attr_t    iface_attr; /* Interface attributes: capabilities and limitations
      */
    uct_iface_h         iface;      /* Communication interface context */
    uct_md_attr_t       md_attr;    /* Memory domain attributes: capabilities and limitations
      */
    uct_md_h            md;         /* Memory domain */
    uct_worker_h        worker;     /* Workers represent allocated resources in a communication
         thread */
} iface_info_t;

/* Helper data type for am_short */
typedef struct {
    uint64_t            header;
    char               *payload;
    size_t              len;
} am_short_args_t;

/* Helper data type for am_bcopy */
typedef struct {
    char                 *data;
    size_t                len;
} am_bcopy_args_t;

/* Helper data type for am_zcopy */
typedef struct {
    uct_completion_t    uct_comp;
    uct_md_h            md;
    uct_mem_h           memh;
} zcopy_comp_t;

static void* desc_holder = NULL;

int print_err_usage(void);

static char *func_am_t_str(func_am_t func_am_type)
{
    switch (func_am_type) {
    case FUNC_AM_SHORT:
        return "uct_ep_am_short";
    case FUNC_AM_BCOPY:
        return "uct_ep_am_bcopy";
    case FUNC_AM_ZCOPY:
        return "uct_ep_am_zcopy";
    }
    return NULL;
}

static size_t func_am_max_size(func_am_t func_am_type,
                               const uct_iface_attr_t *attr)
{
    switch (func_am_type) {
    case FUNC_AM_SHORT:
        return attr->cap.am.max_short;
    case FUNC_AM_BCOPY:
        return attr->cap.am.max_bcopy;
    case FUNC_AM_ZCOPY:
        return attr->cap.am.max_zcopy;
    }
    return 0;
}

/* Helper function for am_short */
void am_short_params_pack(char *buf, size_t len, am_short_args_t *args)
{
    args->header      = *(uint64_t *)buf;
    if (len > sizeof(args->header)) {
        args->payload = (buf + sizeof(args->header));
        args->len     = len - sizeof(args->header);
    } else {
        args->payload = NULL;
        args->len     = 0;
    }
}

ucs_status_t do_am_short(iface_info_t *if_info, uct_ep_h ep, uint8_t id,
                         const cmd_args_t *cmd_args, char *buf)
{
    ucs_status_t    status;
    am_short_args_t send_args;

    am_short_params_pack(buf, cmd_args->test_strlen, &send_args);

    do {
        /* Send active message to remote endpoint */
        status = uct_ep_am_short(ep, id, send_args.header, send_args.payload,
                                 send_args.len);
        uct_worker_progress(if_info->worker);
    } while (status == UCS_ERR_NO_RESOURCE);

    return status;
}

/* Pack callback for am_bcopy */
size_t am_bcopy_data_pack_cb(void *dest, void *arg)
{
    am_bcopy_args_t *bc_args = arg;
    mem_type_memcpy(dest, bc_args->data, bc_args->len);
    return bc_args->len;
}

ucs_status_t do_am_bcopy(iface_info_t *if_info, uct_ep_h ep, uint8_t id,
                         const cmd_args_t *cmd_args, char *buf)
```

```
{
    am_bcopy_args_t args;
    ssize_t len;

    args.data = buf;
    args.len  = cmd_args->test_strlen;

    /* Send active message to remote endpoint */
    do {
        len = uct_ep_am_bcopy(ep, id, am_bcopy_data_pack_cb, &args, 0);
        uct_worker_progress(if_info->worker);
    } while (len == UCS_ERR_NO_RESOURCE);
    /* Negative len is an error code */
    return (len >= 0) ? UCS_OK : (ucs_status_t)len;
}

/* Completion callback for am_zcopy */
void zcopy_completion_cb(uct_completion_t *self)
{
    zcopy_comp_t *comp = (zcopy_comp_t *)self;
    assert((comp->uct_comp.count == 0) && (self->status == UCS_OK));
    if (comp->memh != UCT_MEM_HANDLE_NULL) {
        uct_md_mem_dereg(comp->md, comp->memh);
    }
    desc_holder = (void *)0xDEADBEEF;
}

ucs_status_t do_am_zcopy(iface_info_t *if_info, uct_ep_h ep, uint8_t id,
                         const cmd_args_t *cmd_args, char *buf)
{
    ucs_status_t status = UCS_OK;
    uct_mem_h memh;
    uct_iov_t iov;
    zcopy_comp_t comp;

    if (if_info->md_attr.cap.flags & UCT_MD_FLAG_NEED_MEMH) {
        status = uct_md_mem_reg(if_info->md, buf, cmd_args->test_strlen,
                                UCT_MD_MEM_ACCESS_RMA, &memh);
    } else {
        memh = UCT_MEM_HANDLE_NULL;
    }

    iov.buffer = buf;
    iov.length = cmd_args->test_strlen;
    iov.memh   = memh;
    iov.stride = 0;
    iov.count  = 1;

    comp.uct_comp.func   = zcopy_completion_cb;
    comp.uct_comp.count  = 1;
    comp.uct_comp.status = UCS_OK;
    comp.md              = if_info->md;
    comp.memh            = memh;

    if (status == UCS_OK) {
        do {
            status = uct_ep_am_zcopy(ep, id, NULL, 0, &iov, 1, 0,
                                     (uct_completion_t *)&comp);
            uct_worker_progress(if_info->worker);
        } while (status == UCS_ERR_NO_RESOURCE);

        if (status == UCS_INPROGRESS) {
            while (!desc_holder) {
                /* Explicitly progress outstanding active message request */
                uct_worker_progress(if_info->worker);
            }
            status = UCS_OK;
        }
    }
    return status;
}
static void print_strings(const char *label, const char *local_str,
                          const char *remote_str, size_t length)
{
    fprintf(stdout, "\n\n----- UCT TEST SUCCESS ----\n\n");
    fprintf(stdout, "[%s] %s sent %s (%" PRIu64 " bytes)", label, local_str,
            (length != 0) ? remote_str : "<none>", length);
    fprintf(stdout, "\n\n---------------------------\n");
    fflush(stdout);
}

/* Callback to handle receive active message */
static ucs_status_t hello_world(void *arg, void *data, size_t length,
                                unsigned flags)
{
    func_am_t func_am_type = *(func_am_t *)arg;
    recv_desc_t *rdesc;
    print_strings("callback", func_am_t_str(func_am_type), data, length);

    if (flags & UCT_CB_PARAM_FLAG_DESC) {
        rdesc = (recv_desc_t *)data - 1;
        /* Hold descriptor to release later and return UCS_INPROGRESS */
        rdesc->is_uct_desc = 1;
        desc_holder = rdesc;
        return UCS_INPROGRESS;
    }

    /* We need to copy-out data and return UCS_OK if want to use the data
     * outside the callback */
    rdesc = malloc(sizeof(*rdesc) + length);
    CHKERR_ACTION(rdesc == NULL, "allocate memory\n", return UCS_ERR_NO_MEMORY);
    rdesc->is_uct_desc = 0;
    memcpy(rdesc + 1, data, length);
    desc_holder = rdesc;
    return UCS_OK;
}

/* Init the transport by its name */
static ucs_status_t init_iface(char *dev_name, char *tl_name,
                               func_am_t func_am_type,
                               iface_info_t *iface_p)
{
    ucs_status_t        status;
    uct_iface_config_t  *config; /* Defines interface configuration options */
    uct_iface_params_t  params;

    params.field_mask           = UCT_IFACE_PARAM_FIELD_OPEN_MODE
        |
                                  UCT_IFACE_PARAM_FIELD_DEVICE      |
                                  UCT_IFACE_PARAM_FIELD_STATS_ROOT  |
                                  UCT_IFACE_PARAM_FIELD_RX_HEADROOM |
                                  UCT_IFACE_PARAM_FIELD_CPU_MASK;
    params.open_mode            = UCT_IFACE_OPEN_MODE_DEVICE;
    params.mode.device.tl_name  = tl_name;
    params.mode.device.dev_name = dev_name;
    params.stats_root           = NULL;
    params.rx_headroom          = sizeof(recv_desc_t);

    UCS_CPU_ZERO(&params.cpu_mask);
    /* Read transport-specific interface configuration */
    status = uct_md_iface_config_read(iface_p->md, tl_name, NULL, NULL, &config);
    CHKERR_JUMP(UCS_OK != status, "setup iface_config", error_ret);

    /* Open communication interface */
    assert(iface_p->iface == NULL);
    status = uct_iface_open(iface_p->md, iface_p->worker, &params, config,
                            &iface_p->iface);
    uct_config_release(config);
    CHKERR_JUMP(UCS_OK != status, "open temporary interface", error_ret);

    /* Enable progress on the interface */
    uct_iface_progress_enable(iface_p->iface,
                              UCT_PROGRESS_SEND |
      UCT_PROGRESS_RECV);

    /* Get interface attributes */
    status = uct_iface_query(iface_p->iface, &iface_p->iface_attr);
    CHKERR_JUMP(UCS_OK != status, "query iface", error_iface);

    /* Check if current device and transport support required active messages */
    if ((func_am_type == FUNC_AM_SHORT) &&
        (iface_p->iface_attr.cap.flags & UCT_IFACE_FLAG_AM_SHORT)) {
        if (test_mem_type != UCS_MEMORY_TYPE_CUDA) {
            return UCS_OK;
        } else {
            fprintf(stderr, "AM short protocol doesn't support CUDA memory");
        }
    }

    if ((func_am_type == FUNC_AM_BCOPY) &&
        (iface_p->iface_attr.cap.flags & UCT_IFACE_FLAG_AM_BCOPY)) {
        return UCS_OK;
    }

    if ((func_am_type == FUNC_AM_ZCOPY) &&
        (iface_p->iface_attr.cap.flags & UCT_IFACE_FLAG_AM_ZCOPY)) {
        return UCS_OK;
    }

error_iface:
    uct_iface_close(iface_p->iface);
    iface_p->iface = NULL;
error_ret:
    return UCS_ERR_UNSUPPORTED;
}

/* Device and transport to be used are determined by minimum latency */
static ucs_status_t dev_tl_lookup(const cmd_args_t *cmd_args,
                                  iface_info_t *iface_p)
{
    uct_tl_resource_desc_t *tl_resources    = NULL; /* Communication resource
       descriptor */
    unsigned               num_tl_resources = 0;    /* Number of transport resources resource objects
       created */
    uct_component_h        *components;
    unsigned               num_components;
    unsigned               cmpt_index;
    uct_component_attr_t   component_attr;
    unsigned               md_index;
    unsigned               tl_index;
    uct_md_config_t        *md_config;
    ucs_status_t           status;

    status = uct_query_components(&components, &num_components);
    CHKERR_JUMP(UCS_OK != status, "query for components", error_ret);

    for (cmpt_index = 0; cmpt_index < num_components; ++cmpt_index) {

        component_attr.field_mask =
      UCT_COMPONENT_ATTR_FIELD_MD_RESOURCE_COUNT;
        status = uct_component_query(components[cmpt_index], &component_attr);
        CHKERR_JUMP(UCS_OK != status, "query component attributes",
                    release_component_list);

        component_attr.field_mask =
      UCT_COMPONENT_ATTR_FIELD_MD_RESOURCES;
        component_attr.md_resources = alloca(sizeof(*component_attr.
      md_resources) *
                                             component_attr.md_resource_count);
        status = uct_component_query(components[cmpt_index], &component_attr);
        CHKERR_JUMP(UCS_OK != status, "query for memory domain resources",
                    release_component_list);

        iface_p->iface = NULL;

        /* Iterate through memory domain resources */
        for (md_index = 0; md_index < component_attr.md_resource_count; ++md_index) {
            status = uct_md_config_read(components[cmpt_index], NULL, NULL,
                                        &md_config);
            CHKERR_JUMP(UCS_OK != status, "read MD config",
                        release_component_list);

            status = uct_md_open(components[cmpt_index],
                                 component_attr.md_resources[md_index].
      md_name,
                                 md_config, &iface_p->md);
            uct_config_release(md_config);
            CHKERR_JUMP(UCS_OK != status, "open memory domains",
                        release_component_list);

            status = uct_md_query(iface_p->md, &iface_p->md_attr);
            CHKERR_JUMP(UCS_OK != status, "query iface",
                        close_md);

            status = uct_md_query_tl_resources(iface_p->md, &tl_resources,
                                               &num_tl_resources);
            CHKERR_JUMP(UCS_OK != status, "query transport resources", close_md);

            /* Go through each available transport and find the proper name */
            for (tl_index = 0; tl_index < num_tl_resources; ++tl_index) {
                if (!strcmp(cmd_args->dev_name, tl_resources[tl_index].dev_name) &&
                    !strcmp(cmd_args->tl_name, tl_resources[tl_index].tl_name)) {
                    if ((cmd_args->func_am_type == FUNC_AM_ZCOPY) &&
                        !(iface_p->md_attr.cap.reg_mem_types &
                          UCS_BIT(test_mem_type))) {
                        fprintf(stderr, "Unsupported memory type %s by "
                                UCT_TL_RESOURCE_DESC_FMT" on %s MD\n",
                                ucs_memory_type_names[test_mem_type],
                                UCT_TL_RESOURCE_DESC_ARG(&tl_resources[tl_index]),
                                component_attr.md_resources[md_index].
      md_name);
                        status = UCS_ERR_UNSUPPORTED;
                        break;
                    }

                    status = init_iface(tl_resources[tl_index].dev_name,
                                        tl_resources[tl_index].tl_name,
                                        cmd_args->func_am_type, iface_p);
                    if (status != UCS_OK) {
                        break;
                    }

                    fprintf(stdout, "Using "UCT_TL_RESOURCE_DESC_FMT"\n",
                            UCT_TL_RESOURCE_DESC_ARG(&tl_resources[tl_index]));
                    goto release_tl_resources;
                }
            }

release_tl_resources:
            uct_release_tl_resource_list(tl_resources);
            if ((status == UCS_OK) &&
                (tl_index < num_tl_resources)) {
                goto release_component_list;
            }

            tl_resources     = NULL;
            num_tl_resources = 0;
            uct_md_close(iface_p->md);
        }
    }

    fprintf(stderr, "No supported (dev/tl) found (%s/%s)\n",
            cmd_args->dev_name, cmd_args->tl_name);
    status = UCS_ERR_UNSUPPORTED;

release_component_list:
    uct_release_component_list(components);
error_ret:
    return status;
close_md:
    uct_md_close(iface_p->md);
    goto release_component_list;
}

int print_err_usage()
{
    const char func_template[] = "  -%c      Select \"%s\" function to send the message%s\n";

    fprintf(stderr, "Usage: uct_hello_world [parameters]\n");
    fprintf(stderr, "UCT hello world client/server example utility\n");
    fprintf(stderr, "\nParameters are:\n");
    fprintf(stderr, func_template, 'i', func_am_t_str(FUNC_AM_SHORT), " (default)");
    fprintf(stderr, func_template, 'b', func_am_t_str(FUNC_AM_BCOPY), "");
    fprintf(stderr, func_template, 'z', func_am_t_str(FUNC_AM_ZCOPY), "");
    fprintf(stderr, "  -d        Select device name\n");
    fprintf(stderr, "  -t        Select transport layer\n");
    fprintf(stderr, "  -n <name> Set node name or IP address "
            "of the server (required for client and should be ignored "
            "for server)\n");
    print_common_help();
    fprintf(stderr, "\nExample:\n");
    fprintf(stderr, "  Server: uct_hello_world -d eth0 -t tcp\n");
    fprintf(stderr, "  Client: uct_hello_world -d eth0 -t tcp -n localhost\n");

    return UCS_ERR_UNSUPPORTED;
}

int parse_cmd(int argc, char * const argv[], cmd_args_t *args)
{
    int c = 0, idx = 0;

    assert(args);
    memset(args, 0, sizeof(*args));

    /* Defaults */
    args->server_port   = 13337;
    args->ai_family     = AF_INET;
    args->func_am_type  = FUNC_AM_SHORT;
    args->test_strlen   = 16;

    while ((c = getopt(argc, argv, "6ibzd:t:n:p:s:m:h")) != -1) {
        switch (c) {
        case 'i':
            args->func_am_type = FUNC_AM_SHORT;
            break;
        case 'b':
            args->func_am_type = FUNC_AM_BCOPY;
            break;
        case 'z':
            args->func_am_type = FUNC_AM_ZCOPY;
            break;
        case 'd':
            args->dev_name = optarg;
            break;
        case 't':
            args->tl_name = optarg;
            break;
        case 'n':
            args->server_name = optarg;
            break;
        case '6':
            args->ai_family = AF_INET6;
            break;
        case 'p':
            args->server_port = atoi(optarg);
            if (args->server_port <= 0) {
                fprintf(stderr, "Wrong server port number %d\n",
                        args->server_port);
                return UCS_ERR_UNSUPPORTED;
            }
            break;
        case 's':
            args->test_strlen = atol(optarg);
            if (args->test_strlen < 0) {
                fprintf(stderr, "Wrong string size %ld\n", args->test_strlen);
                return UCS_ERR_UNSUPPORTED;
            }
            break;
        case 'm':
            test_mem_type = parse_mem_type(optarg);
            if (test_mem_type == UCS_MEMORY_TYPE_LAST) {
                return UCS_ERR_UNSUPPORTED;
            }
            break;
        case 'h':
        default:
            return print_err_usage();
        }
    }
    fprintf(stdout, "INFO: UCT_HELLO_WORLD AM function = %s server = %s port = %d\n",
            func_am_t_str(args->func_am_type), args->server_name,
            args->server_port);

    for (idx = optind; idx < argc; idx++) {
        fprintf(stderr, "WARNING: Non-option argument %s\n", argv[idx]);
    }

    if (args->dev_name == NULL) {
        fprintf(stderr, "WARNING: device is not set\n");
        return print_err_usage();
    }

    if (args->tl_name == NULL) {
        fprintf(stderr, "WARNING: transport layer is not set\n");
        return print_err_usage();
    }

    return UCS_OK;
}

/* The caller is responsible to free *rbuf */
int sendrecv(int sock, const void *sbuf, size_t slen, void **rbuf)
{
    int ret = 0;
    size_t rlen = 0;
    *rbuf = NULL;

    ret = send(sock, &slen, sizeof(slen), 0);
    if ((ret < 0) || (ret != sizeof(slen))) {
        fprintf(stderr, "failed to send buffer length\n");
        return -1;
    }

    ret = send(sock, sbuf, slen, 0);
    if (ret != (int)slen) {
        fprintf(stderr, "failed to send buffer, return value %d\n", ret);
        return -1;
    }

    ret = recv(sock, &rlen, sizeof(rlen), MSG_WAITALL);
    if ((ret != sizeof(rlen)) || (rlen > (SIZE_MAX / 2))) {
        fprintf(stderr,
                "failed to receive device address length, return value %d\n",
                ret);
        return -1;
    }

    *rbuf = calloc(1, rlen);
    if (!*rbuf) {
        fprintf(stderr, "failed to allocate receive buffer\n");
        return -1;
    }

    ret = recv(sock, *rbuf, rlen, MSG_WAITALL);
    if (ret != (int)rlen) {
        fprintf(stderr, "failed to receive device address, return value %d\n",
                ret);
        return -1;
    }

    return 0;
}

static void progress_worker(void *arg)
{
    uct_worker_progress((uct_worker_h)arg);
}

int main(int argc, char **argv)
{
    uct_device_addr_t   *peer_dev   = NULL;
    uct_iface_addr_t    *peer_iface = NULL;
    uct_ep_addr_t       *own_ep     = NULL;
    uct_ep_addr_t       *peer_ep    = NULL;
    uint8_t              id         = 0;
    int                  oob_sock   = -1;  /* OOB connection socket */
    ucs_status_t         status     = UCS_OK; /* status codes for UCS */
    uct_device_addr_t   *own_dev;
    uct_iface_addr_t    *own_iface;
    uct_ep_h             ep;                  /* Remote endpoint */
    ucs_async_context_t *async;               /* Async event context manages
                                                 times and fd notifications */
    cmd_args_t           cmd_args;
    iface_info_t         if_info;
    uct_ep_params_t      ep_params;
    int                  res;

    /* Parse the command line */
    if (parse_cmd(argc, argv, &cmd_args)) {
        status = UCS_ERR_INVALID_PARAM;
        goto out;
    }

    /* Initialize context
     * It is better to use different contexts for different workers */
    status = ucs_async_context_create(UCS_ASYNC_MODE_THREAD_SPINLOCK, &async);
    CHKERR_JUMP(UCS_OK != status, "init async context", out);

    /* Create a worker object */
    status = uct_worker_create(async, UCS_THREAD_MODE_SINGLE, &
      if_info.worker);
    CHKERR_JUMP(UCS_OK != status, "create worker", out_cleanup_async);

    /* Search for the desired transport */
    status = dev_tl_lookup(&cmd_args, &if_info);
    CHKERR_JUMP(UCS_OK != status, "find supported device and transport",
                out_destroy_worker);

    /* Set active message handler */
    status = uct_iface_set_am_handler(if_info.iface, id, hello_world,
                                      &cmd_args.func_am_type, 0);
    CHKERR_JUMP(UCS_OK != status, "set callback", out_destroy_iface);

    own_dev = (uct_device_addr_t*)calloc(1, if_info.iface_attr.device_addr_len);
    CHKERR_JUMP(NULL == own_dev, "allocate memory for dev addr",
                out_destroy_iface);

    own_iface = (uct_iface_addr_t*)calloc(1, if_info.iface_attr.iface_addr_len);
    CHKERR_JUMP(NULL == own_iface, "allocate memory for if addr",
                out_free_dev_addrs);

    oob_sock = connect_common(cmd_args.server_name, cmd_args.server_port,
                              cmd_args.ai_family);

    CHKERR_ACTION(oob_sock < 0, "OOB connect",
                  status = UCS_ERR_IO_ERROR; goto out_close_oob_sock);

    /* Get device address */
    if (if_info.iface_attr.device_addr_len > 0) {
        status = uct_iface_get_device_address(if_info.iface, own_dev);
        CHKERR_JUMP(UCS_OK != status, "get device address", out_free_if_addrs);

        res = sendrecv(oob_sock, own_dev, if_info.iface_attr.device_addr_len,
                       (void**)&peer_dev);
        CHKERR_ACTION(0 != res, "device exchange", status = UCS_ERR_NO_MESSAGE;
                      goto out_close_oob_sock);
    }

    /* Get interface address */
    if (if_info.iface_attr.iface_addr_len > 0) {
        status = uct_iface_get_address(if_info.iface, own_iface);
        CHKERR_JUMP(UCS_OK != status, "get interface address",
                    out_close_oob_sock);

        status = (ucs_status_t)sendrecv(oob_sock, own_iface, if_info.iface_attr.iface_addr_len,
                                        (void **)&peer_iface);
        CHKERR_JUMP(0 != status, "ifaces exchange", out_close_oob_sock);
    }

    status = (ucs_status_t)uct_iface_is_reachable(if_info.iface, peer_dev
      ,
                                                  peer_iface);
    CHKERR_JUMP(0 == status, "reach the peer", out_close_oob_sock);

    ep_params.field_mask = UCT_EP_PARAM_FIELD_IFACE;
    ep_params.iface      = if_info.iface;
    if (if_info.iface_attr.cap.flags & UCT_IFACE_FLAG_CONNECT_TO_EP) {
        own_ep = (uct_ep_addr_t*)calloc(1, if_info.iface_attr.ep_addr_len);
        CHKERR_ACTION(NULL == own_ep, "allocate memory for ep addrs",
                      status = UCS_ERR_NO_MEMORY; goto out_close_oob_sock);

        /* Create new endpoint */
        status = uct_ep_create(&ep_params, &ep);
        CHKERR_JUMP(UCS_OK != status, "create endpoint", out_free_ep_addrs);

        /* Get endpoint address */
        status = uct_ep_get_address(ep, own_ep);
        CHKERR_JUMP(UCS_OK != status, "get endpoint address", out_free_ep);

        status = (ucs_status_t)sendrecv(oob_sock, own_ep, if_info.iface_attr.ep_addr_len,
                                        (void **)&peer_ep);
        CHKERR_JUMP(0 != status, "EPs exchange", out_free_ep);

        /* Connect endpoint to a remote endpoint */
        status = uct_ep_connect_to_ep(ep, peer_dev, peer_ep);
        if (barrier(oob_sock, progress_worker, if_info.worker)) {
            status = UCS_ERR_IO_ERROR;
            goto out_free_ep;
        }
    } else if (if_info.iface_attr.cap.flags & UCT_IFACE_FLAG_CONNECT_TO_IFACE
      ) {
        /* Create an endpoint which is connected to a remote interface */
        ep_params.field_mask |= UCT_EP_PARAM_FIELD_DEV_ADDR |
                                UCT_EP_PARAM_FIELD_IFACE_ADDR;
        ep_params.dev_addr    = peer_dev;
        ep_params.iface_addr  = peer_iface;
        status = uct_ep_create(&ep_params, &ep);
        CHKERR_JUMP(UCS_OK != status, "create endpoint", out_free_ep_addrs);
    } else {
        status = UCS_ERR_UNSUPPORTED;
        goto out_free_ep_addrs;
    }

    if (cmd_args.test_strlen > func_am_max_size(cmd_args.func_am_type, &if_info.iface_attr)) {
        status = UCS_ERR_UNSUPPORTED;
        fprintf(stderr, "Test string is too long: %ld, max supported: %lu\n",
                cmd_args.test_strlen,
                func_am_max_size(cmd_args.func_am_type, &if_info.iface_attr));
        goto out_free_ep;
    }

    if (cmd_args.server_name) {
        char *str = (char *)mem_type_malloc(cmd_args.test_strlen);
        CHKERR_ACTION(str == NULL, "allocate memory",
                      status = UCS_ERR_NO_MEMORY; goto out_free_ep);
        res = generate_test_string(str, cmd_args.test_strlen);
        CHKERR_ACTION(res < 0, "generate test string",
                      status = UCS_ERR_NO_MEMORY; goto out_free_ep);

        /* Send active message to remote endpoint */
        if (cmd_args.func_am_type == FUNC_AM_SHORT) {
            status = do_am_short(&if_info, ep, id, &cmd_args, str);
        } else if (cmd_args.func_am_type == FUNC_AM_BCOPY) {
            status = do_am_bcopy(&if_info, ep, id, &cmd_args, str);
        } else if (cmd_args.func_am_type == FUNC_AM_ZCOPY) {
            status = do_am_zcopy(&if_info, ep, id, &cmd_args, str);
        }

        mem_type_free(str);
        CHKERR_JUMP(UCS_OK != status, "send active msg", out_free_ep);
    } else {
        recv_desc_t *rdesc;

        while (desc_holder == NULL) {
            /* Explicitly progress any outstanding active message requests */
            uct_worker_progress(if_info.worker);
        }
        rdesc = desc_holder;
        print_strings("main", func_am_t_str(cmd_args.func_am_type),
                      (char *)(rdesc + 1), cmd_args.test_strlen);

        if (rdesc->is_uct_desc) {
            /* Release descriptor because callback returns UCS_INPROGRESS */
            uct_iface_release_desc(rdesc);
        } else {
            free(rdesc);
        }
    }

    if (barrier(oob_sock, progress_worker, if_info.worker)) {
        status = UCS_ERR_IO_ERROR;
    }

out_free_ep:
    uct_ep_destroy(ep);
out_free_ep_addrs:
    free(own_ep);
    free(peer_ep);
out_close_oob_sock:
    close(oob_sock);
out_free_if_addrs:
    free(own_iface);
    free(peer_iface);
out_free_dev_addrs:
    free(own_dev);
    free(peer_dev);
out_destroy_iface:
    uct_iface_close(if_info.iface);
    uct_md_close(if_info.md);
out_destroy_worker:
    uct_worker_destroy(if_info.worker);
out_cleanup_async:
    ucs_async_context_destroy(async);
out:
    return (status == UCS_ERR_UNSUPPORTED) ? UCS_OK : status;
}
```

Index

completed_cb
    uct_tag_context, 258

finish
    UCP Data type routines, 143

pack
    UCP Data type routines, 142
packed_size
    UCP Data type routines, 142
priv
    uct_tag_context, 259

rndv_cb
    uct_tag_context, 258

start_pack
    UCP Data type routines, 141
start_unpack
    UCP Data type routines, 141

tag_consumed_cb
    uct_tag_context, 258

UCP Application Context, 14
    UCP_ENTITY_NAME_MAX, 18
    ucp_cleanup, 22
    ucp_context_attr_field, 20
    ucp_context_attr_t, 18
    ucp_context_h, 18
    ucp_context_print_info, 23
    ucp_context_query, 23
    ucp_feature, 20
    ucp_get_version, 21
    ucp_get_version_string, 21
    ucp_init, 21
    ucp_lib_attr_field, 20
    ucp_lib_attr_t, 18
    ucp_lib_query, 21
    ucp_params_field, 19
    ucp_request_cleanup_callback_t, 19
    ucp_request_init_callback_t, 19
    ucp_tag_recv_info_t, 18
UCP Communication routines, 86
    ucp_am_data_release, 99
    ucp_am_handler_param_field, 96
    ucp_am_recv_attr_t, 95
    ucp_am_recv_data_nbx, 98
    ucp_am_recv_data_nbx_callback_t, 93
    ucp_am_send_nb, 118
    ucp_am_send_nbx, 97
    ucp_atomic_add32, 112
    ucp_atomic_add64, 113
    ucp_atomic_cswap32, 116
    ucp_atomic_cswap64, 117
    ucp_atomic_fadd32, 113
    ucp_atomic_fadd64, 114
    ucp_atomic_fetch_nb, 129
    ucp_atomic_fetch_op_t, 96
    ucp_atomic_op_nbx, 107
    ucp_atomic_op_t, 94
    ucp_atomic_post, 128
    ucp_atomic_post_op_t, 96
    ucp_atomic_swap32, 115
    ucp_atomic_swap64, 116
    ucp_datatype_t, 91
    ucp_err_handler_cb_t, 91
    ucp_err_handler_t, 92
    ucp_get, 111
    ucp_get_nb, 128
    ucp_get_nbi, 127
    ucp_get_nbx, 106
    ucp_op_attr_t, 94
    ucp_put, 110
    ucp_put_nb, 126
    ucp_put_nbi, 125
    ucp_put_nbx, 105
    ucp_req_attr_field, 95
    ucp_request_alloc, 110
    ucp_request_cancel, 109
    ucp_request_check_status, 108
    ucp_request_free, 110
    ucp_request_is_completed, 110
    ucp_request_query, 97
    ucp_send_callback_t, 91
    ucp_send_nbx_callback_t, 91
    ucp_stream_data_release, 109
    ucp_stream_recv_callback_t, 92
    ucp_stream_recv_data_nb, 102
    ucp_stream_recv_flags_t, 94
    ucp_stream_recv_nb, 119
    ucp_stream_recv_nbx, 101
    ucp_stream_recv_nbx_callback_t, 92
    ucp_stream_recv_request_test, 109
    ucp_stream_send_nb, 118
    ucp_stream_send_nbx, 99
    ucp_tag_message_h, 90
    ucp_tag_msg_recv_nb, 125
    ucp_tag_msg_recv_nbx, 104
    ucp_tag_probe_nb, 103

ucp_tag_recv_callback_t, 92
ucp_tag_recv_nb, 123
ucp_tag_recv_nbr, 124
ucp_tag_recv_nbx, 103
ucp_tag_recv_nbx_callback_t, 93
ucp_tag_recv_request_test, 108
ucp_tag_send_nb, 120
ucp_tag_send_nbr, 121
ucp_tag_send_nbx, 100
ucp_tag_send_sync_nb, 122
ucp_tag_send_sync_nbx, 101
ucp_tag_t, 90
UCP Configuration, 131
ucp_config_modify, 134
ucp_config_print, 135
ucp_config_read, 134
ucp_config_release, 134
ucp_config_t, 133
ucp_params_t, 133
UCP Data type routines, 136
finish, 143
pack, 142
packed_size, 142
start_pack, 141
start_unpack, 141
ucp_datatype_attr_field, 139
ucp_datatype_attr_t, 139
ucp_dt_create_generic, 140
ucp_dt_destroy, 140
ucp_dt_iov_t, 138
ucp_dt_make_contig, 138
ucp_dt_make_iov, 138
ucp_dt_query, 141
ucp_dt_type, 139
ucp_generic_dt_ops_t, 139
unpack, 142
UCP Endpoint, 68
ucp_am_callback_t, 74
ucp_am_recv_callback_t, 74
ucp_cb_param_flags, 77
ucp_conn_request_h, 74
ucp_disconnect_nb, 83
ucp_ep_attr_field, 78
ucp_ep_attr_t, 73
ucp_ep_close_flags_t, 76
ucp_ep_close_mode, 78
ucp_ep_close_nb, 84
ucp_ep_close_nbx, 79
ucp_ep_create, 79
ucp_ep_destroy, 83
ucp_ep_evaluate_perf, 81
ucp_ep_flush, 83
ucp_ep_flush_nb, 85
ucp_ep_flush_nbx, 80
ucp_ep_h, 74
ucp_ep_modify_nb, 84
ucp_ep_params_field, 75
ucp_ep_params_flags_field, 76
ucp_ep_params_t, 75
ucp_ep_perf_attr_field, 77
ucp_ep_perf_attr_field_t, 73
ucp_ep_perf_param_field, 77
ucp_ep_perf_param_field_t, 73
ucp_ep_print_info, 80
ucp_ep_query, 81
ucp_err_handling_mode_t, 78
ucp_request_release, 83
ucp_request_test, 83
ucp_stream_poll_ep_t, 73
UCP Memory routines, 48
ucp_ep_rkey_unpack, 60
ucp_mem_advice, 54
ucp_mem_advice_t, 52
ucp_mem_advise, 59
ucp_mem_advise_params_field, 53
ucp_mem_advise_params_t, 52
ucp_mem_attr_field, 55
ucp_mem_attr_t, 53
ucp_mem_h, 53
ucp_mem_map, 56
ucp_mem_map_params_field, 53
ucp_mem_map_params_t, 52
ucp_mem_print_info, 58
ucp_mem_query, 58
ucp_mem_unmap, 57
ucp_memh_buffer_release, 60
ucp_memh_buffer_release_params_t, 52
ucp_memh_pack, 59
ucp_memh_pack_flags, 55
ucp_memh_pack_params_field, 55
ucp_memh_pack_params_t, 52
ucp_rkey_buffer_release, 62
ucp_rkey_compare, 56
ucp_rkey_compare_params_t, 52
ucp_rkey_destroy, 61
ucp_rkey_h, 52
ucp_rkey_pack, 62
ucp_rkey_ptr, 61
UCP Wake-up routines, 64
ucp_worker_arm, 66
ucp_worker_get_efd, 64
ucp_worker_signal, 67
ucp_worker_wait, 65
ucp_worker_wait_mem, 65
UCP Worker, 24
ucp_address_t, 32
ucp_am_cb_flags, 36
ucp_am_handler_param_t, 32
ucp_am_recv_param_t, 32
ucp_conn_request_attr_field, 36
ucp_conn_request_attr_t, 32
ucp_conn_request_query, 43
ucp_listener_accept_callback_t, 33
ucp_listener_accept_handler_t, 32
ucp_listener_attr_field, 36
ucp_listener_attr_t, 32

ucp_listener_conn_callback_t, 33
ucp_listener_conn_handler_t, 34
ucp_listener_create, 41
ucp_listener_destroy, 42
ucp_listener_h, 32
ucp_listener_params_field, 35
ucp_listener_params_t, 32
ucp_listener_query, 42
ucp_listener_reject, 43
ucp_send_am_flags, 37
ucp_stream_worker_poll, 41
ucp_wakeup_event_t, 34
ucp_wakeup_event_types, 37
ucp_worker_address_attr_field, 36
ucp_worker_address_attr_t, 32
ucp_worker_address_flags_t, 35
ucp_worker_address_query, 40
ucp_worker_attr_field, 35
ucp_worker_attr_t, 31
ucp_worker_create, 38
ucp_worker_destroy, 38
ucp_worker_fence, 44
ucp_worker_flags_t, 35
ucp_worker_flush, 45
ucp_worker_flush_nb, 47
ucp_worker_flush_nbx, 44
ucp_worker_get_address, 46
ucp_worker_h, 33
ucp_worker_params_field, 34
ucp_worker_params_t, 31
ucp_worker_print_info, 39
ucp_worker_progress, 40
ucp_worker_query, 39
ucp_worker_release_address, 39
ucp_worker_set_am_handler, 46
ucp_worker_set_am_recv_handler, 43
UCP_ENTITY_NAME_MAX
UCP Application Context, 18
UCS Communication Resource, 249
ucs_async_add_timer, 254
ucs_async_context_create, 255
ucs_async_context_destroy, 255
ucs_async_event_cb_t, 250
ucs_async_modify_handler, 255
ucs_async_poll, 256
ucs_async_remove_handler, 254
ucs_async_set_event_handler, 253
ucs_callbackq_flags, 251
ucs_memory_type, 251
ucs_memory_type_t, 251
ucs_sock_addr_t, 250
ucs_status_ptr_t, 251
ucs_status_t, 252
ucs_thread_mode_t, 253
ucs_time_t, 251
UCT Active messages, 204
uct_am_callback_t, 204
uct_am_trace_type, 206
uct_am_tracer_t, 205
uct_ep_am_bcopy, 208
uct_ep_am_short, 207
uct_ep_am_short_iov, 208
uct_ep_am_zcopy, 208
uct_iface_release_desc, 207
uct_iface_set_am_handler, 206
uct_iface_set_am_tracer, 207
uct_msg_flags, 205
UCT Atomic operations, 213
uct_ep_atomic32_fetch, 214
uct_ep_atomic32_post, 213
uct_ep_atomic64_fetch, 214
uct_ep_atomic64_post, 214
uct_ep_atomic_cswap32, 213
uct_ep_atomic_cswap64, 213
UCT client-server operations, 223
uct_cm_attr_field, 232
uct_cm_client_ep_conn_notify, 239
uct_cm_close, 238
uct_cm_config_read, 238
uct_cm_ep_client_connect_args_field, 235
uct_cm_ep_client_connect_args_t, 230
uct_cm_ep_client_connect_callback_t, 231
uct_cm_ep_priv_data_pack_args_field, 233
uct_cm_ep_priv_data_pack_args_t, 229
uct_cm_ep_priv_data_pack_callback_t, 231
uct_cm_ep_resolve_args_field, 234
uct_cm_ep_resolve_args_t, 229
uct_cm_ep_resolve_callback_t, 232
uct_cm_ep_server_conn_notify_args_field, 235
uct_cm_ep_server_conn_notify_args_t, 230
uct_cm_ep_server_conn_notify_callback_t, 230
uct_cm_listener_conn_request_args_field, 234
uct_cm_listener_conn_request_args_t, 229
uct_cm_listener_conn_request_callback_t, 230
uct_cm_open, 237
uct_cm_query, 238
uct_cm_remote_data_field, 234
uct_cm_remote_data_t, 229
uct_ep_connect, 236
uct_ep_connect_params_field, 233
uct_ep_disconnect, 237
uct_ep_disconnect_cb_t, 231
uct_iface_accept, 236
uct_iface_reject, 236
uct_listener_attr_field, 233
uct_listener_create, 239
uct_listener_destroy, 239
uct_listener_params_field, 233
uct_listener_query, 240
uct_listener_reject, 240
uct_sockaddr_conn_request_callback_t, 230
UCT Communication Context, 185
uct_alloc_method_t, 185
uct_config_get, 187
uct_config_modify, 189
uct_worker_create, 186

uct_worker_destroy, 186
uct_worker_progress, 189
uct_worker_progress_register_safe, 186
uct_worker_progress_unregister_safe, 187
UCT Communication Resource, 145
uct_am_trace_type_t, 162
uct_async_event_cb_t, 166
uct_cb_flags, 168
uct_cb_param_flags, 171
uct_cm_attr_t, 162
uct_cm_config_t, 160
uct_cm_h, 163
uct_cm_t, 162
uct_completion_callback_t, 164
uct_completion_t, 161
uct_completion_update_status, 184
uct_component_attr_field, 166
uct_component_attr_t, 159
uct_component_h, 160
uct_component_query, 172
uct_config_release, 174
uct_conn_request_h, 163
uct_device_addr_t, 162
uct_device_type_t, 167
uct_ep_addr_t, 162
uct_ep_attr_t, 161
uct_ep_check, 177
uct_ep_connect_params_t, 162
uct_ep_connect_to_ep, 180
uct_ep_create, 179
uct_ep_destroy, 180
uct_ep_fence, 183
uct_ep_flush, 182
uct_ep_get_address, 180
uct_ep_h, 160
uct_ep_params_field, 169
uct_ep_params_t, 162
uct_ep_pending_add, 182
uct_ep_pending_purge, 182
uct_error_handler_t, 164
uct_flush_flags, 167
uct_iface_addr_t, 162
uct_iface_attr_t, 161
uct_iface_close, 175
uct_iface_config_t, 160
uct_iface_event_arm, 178
uct_iface_event_fd_get, 177
uct_iface_event_types, 167
uct_iface_feature, 170
uct_iface_fence, 181
uct_iface_flush, 181
uct_iface_get_address, 176
uct_iface_get_device_address, 176
uct_iface_h, 160
uct_iface_is_reachable, 177
uct_iface_mem_alloc, 178
uct_iface_mem_free, 179
uct_iface_open, 175
uct_iface_open_mode, 168
uct_iface_params_field, 169
uct_iface_params_t, 161
uct_iface_progress, 184
uct_iface_progress_disable, 184
uct_iface_progress_enable, 183
uct_iface_query, 176
uct_iov_t, 163
uct_listener_attr_t, 163
uct_listener_h, 163
uct_listener_params_t, 163
uct_md_attr_t, 161
uct_md_close, 173
uct_md_config_t, 160
uct_md_h, 160
uct_md_iface_config_read, 174
uct_md_open, 172
uct_md_ops_t, 161
uct_md_query_tl_resources, 173
uct_md_resource_desc_t, 159
uct_md_t, 162
uct_mem_h, 160
uct_pack_callback_t, 165
uct_pending_callback_t, 164
uct_pending_purge_callback_t, 165
uct_pending_req_t, 161
uct_progress_types, 168
uct_query_components, 171
uct_release_component_list, 171
uct_release_tl_resource_list, 174
uct_rkey_ctx_h, 161
uct_rkey_t, 160
uct_tag_context_t, 163
uct_tag_t, 163
uct_tl_resource_desc_t, 159
uct_unpack_callback_t, 165
uct_worker_cb_id_t, 163
uct_worker_h, 161
UCT interface for asynchronous event capabilities, 247
UCT_IFACE_FLAG_EVENT_ASYNC_CB, 247
UCT_IFACE_FLAG_EVENT_FD, 247
UCT_IFACE_FLAG_EVENT_RECV_SIG, 247
UCT_IFACE_FLAG_EVENT_RECV, 247
UCT_IFACE_FLAG_EVENT_SEND_COMP, 247
UCT interface operations and capabilities, 241
UCT_IFACE_FLAG_AM_BCOPY, 242
UCT_IFACE_FLAG_AM_DUP, 244
UCT_IFACE_FLAG_AM_SHORT, 241
UCT_IFACE_FLAG_AM_ZCOPY, 242
UCT_IFACE_FLAG_ATOMIC_CPU, 243
UCT_IFACE_FLAG_ATOMIC_DEVICE, 243
UCT_IFACE_FLAG_CB_ASYNC, 245
UCT_IFACE_FLAG_CB_SYNC, 245
UCT_IFACE_FLAG_CONNECT_TO_EP, 244
UCT_IFACE_FLAG_CONNECT_TO_IFACE, 244
UCT_IFACE_FLAG_CONNECT_TO_SOCKAD↩
DR, 244
UCT_IFACE_FLAG_EP_CHECK, 244

UCT_IFACE_FLAG_EP_KEEPALIVE, 245
UCT_IFACE_FLAG_ERRHANDLE_AM_ID, 243
UCT_IFACE_FLAG_ERRHANDLE_BCOPY_BUF, 243
UCT_IFACE_FLAG_ERRHANDLE_BCOPY_LEN, 244
UCT_IFACE_FLAG_ERRHANDLE_PEER_FAIL↩URE, 244
UCT_IFACE_FLAG_ERRHANDLE_REMOTE_↩MEM, 243
UCT_IFACE_FLAG_ERRHANDLE_SHORT_BUF, 243
UCT_IFACE_FLAG_ERRHANDLE_ZCOPY_BUF, 243
UCT_IFACE_FLAG_GET_BCOPY, 243
UCT_IFACE_FLAG_GET_SHORT, 242
UCT_IFACE_FLAG_GET_ZCOPY, 243
UCT_IFACE_FLAG_INTER_NODE, 245
UCT_IFACE_FLAG_PENDING, 242
UCT_IFACE_FLAG_PUT_BCOPY, 242
UCT_IFACE_FLAG_PUT_SHORT, 242
UCT_IFACE_FLAG_PUT_ZCOPY, 242
UCT_IFACE_FLAG_TAG_EAGER_BCOPY, 245
UCT_IFACE_FLAG_TAG_EAGER_SHORT, 245
UCT_IFACE_FLAG_TAG_EAGER_ZCOPY, 245
UCT_IFACE_FLAG_TAG_RNDV_ZCOPY, 245
UCT Memory Domain, 190
uct_allocated_memory_t, 195
uct_md_config_read, 201
uct_md_detect_memory_type, 200
uct_md_is_sockaddr_accessible, 201
uct_md_mem_advise, 199
uct_md_mem_attr_field, 197
uct_md_mem_attr_field_t, 194
uct_md_mem_attr_t, 194
uct_md_mem_dereg, 199
uct_md_mem_flags, 196
uct_md_mem_query, 198
uct_md_mem_reg, 199
uct_md_mkey_pack, 202
uct_md_query, 198
uct_mem_advice_t, 197
uct_mem_alloc, 200
uct_mem_alloc_params_field_t, 197
uct_mem_free, 201
uct_rkey_bundle_t, 195
uct_rkey_ptr, 203
uct_rkey_release, 203
uct_rkey_unpack, 202
uct_sockaddr_accessibility_t, 195
UCT Remote memory access operations, 210
uct_ep_get_bcopy, 211
uct_ep_get_short, 211
uct_ep_get_zcopy, 211
uct_ep_put_bcopy, 210
uct_ep_put_short, 210
uct_ep_put_zcopy, 210
UCT Tag matching operations, 215
uct_ep_tag_eager_bcopy, 218
uct_ep_tag_eager_short, 217
uct_ep_tag_eager_zcopy, 218
uct_ep_tag_rndv_cancel, 220
uct_ep_tag_rndv_request, 220
uct_ep_tag_rndv_zcopy, 219
uct_iface_tag_recv_cancel, 221
uct_iface_tag_recv_zcopy, 221
uct_tag_unexp_eager_cb_t, 215
uct_tag_unexp_rndv_cb_t, 216
UCT_IFACE_FLAG_AM_BCOPY
UCT interface operations and capabilities, 242
UCT_IFACE_FLAG_AM_DUP
UCT interface operations and capabilities, 244
UCT_IFACE_FLAG_AM_SHORT
UCT interface operations and capabilities, 241
UCT_IFACE_FLAG_AM_ZCOPY
UCT interface operations and capabilities, 242
UCT_IFACE_FLAG_ATOMIC_CPU
UCT interface operations and capabilities, 243
UCT_IFACE_FLAG_ATOMIC_DEVICE
UCT interface operations and capabilities, 243
UCT_IFACE_FLAG_CB_ASYNC
UCT interface operations and capabilities, 245
UCT_IFACE_FLAG_CB_SYNC
UCT interface operations and capabilities, 245
UCT_IFACE_FLAG_CONNECT_TO_EP
UCT interface operations and capabilities, 244
UCT_IFACE_FLAG_CONNECT_TO_IFACE
UCT interface operations and capabilities, 244
UCT_IFACE_FLAG_CONNECT_TO_SOCKADDR
UCT interface operations and capabilities, 244
UCT_IFACE_FLAG_EP_CHECK
UCT interface operations and capabilities, 244
UCT_IFACE_FLAG_EP_KEEPALIVE
UCT interface operations and capabilities, 245
UCT_IFACE_FLAG_ERRHANDLE_AM_ID
UCT interface operations and capabilities, 243
UCT_IFACE_FLAG_ERRHANDLE_BCOPY_BUF
UCT interface operations and capabilities, 243
UCT_IFACE_FLAG_ERRHANDLE_BCOPY_LEN
UCT interface operations and capabilities, 244
UCT_IFACE_FLAG_ERRHANDLE_PEER_FAILURE
UCT interface operations and capabilities, 244
UCT_IFACE_FLAG_ERRHANDLE_REMOTE_MEM
UCT interface operations and capabilities, 243
UCT_IFACE_FLAG_ERRHANDLE_SHORT_BUF
UCT interface operations and capabilities, 243
UCT_IFACE_FLAG_ERRHANDLE_ZCOPY_BUF
UCT interface operations and capabilities, 243
UCT_IFACE_FLAG_EVENT_ASYNC_CB
UCT interface for asynchronous event capabilities, 247
UCT_IFACE_FLAG_EVENT_FD
UCT interface for asynchronous event capabilities, 247
UCT_IFACE_FLAG_EVENT_RECV_SIG

UCT interface for asynchronous event capabilities, 247
UCT_IFACE_FLAG_EVENT_RECV
UCT interface for asynchronous event capabilities, 247
UCT_IFACE_FLAG_EVENT_SEND_COMP
UCT interface for asynchronous event capabilities, 247
UCT_IFACE_FLAG_GET_BCOPY
UCT interface operations and capabilities, 243
UCT_IFACE_FLAG_GET_SHORT
UCT interface operations and capabilities, 242
UCT_IFACE_FLAG_GET_ZCOPY
UCT interface operations and capabilities, 243
UCT_IFACE_FLAG_INTER_NODE
UCT interface operations and capabilities, 245
UCT_IFACE_FLAG_PENDING
UCT interface operations and capabilities, 242
UCT_IFACE_FLAG_PUT_BCOPY
UCT interface operations and capabilities, 242
UCT_IFACE_FLAG_PUT_SHORT
UCT interface operations and capabilities, 242
UCT_IFACE_FLAG_PUT_ZCOPY
UCT interface operations and capabilities, 242
UCT_IFACE_FLAG_TAG_EAGER_BCOPY
UCT interface operations and capabilities, 245
UCT_IFACE_FLAG_TAG_EAGER_SHORT
UCT interface operations and capabilities, 245
UCT_IFACE_FLAG_TAG_EAGER_ZCOPY
UCT interface operations and capabilities, 245
UCT_IFACE_FLAG_TAG_RNDV_ZCOPY
UCT interface operations and capabilities, 245
ucp_address_t
UCP Worker, 32
ucp_am_callback_t
UCP Endpoint, 74
ucp_am_cb_flags
UCP Worker, 36
ucp_am_data_release
UCP Communication routines, 99
ucp_am_handler_param, 30
ucp_am_handler_param_field
UCP Communication routines, 96
ucp_am_handler_param_t
UCP Worker, 32
ucp_am_recv_attr_t
UCP Communication routines, 95
ucp_am_recv_callback_t
UCP Endpoint, 74
ucp_am_recv_data_nbx
UCP Communication routines, 98
ucp_am_recv_data_nbx_callback_t
UCP Communication routines, 93
ucp_am_recv_param, 31
ucp_am_recv_param_t
UCP Worker, 32
ucp_am_send_nb
UCP Communication routines, 118
ucp_am_send_nbx
UCP Communication routines, 97
ucp_atomic_add32
UCP Communication routines, 112
ucp_atomic_add64
UCP Communication routines, 113
ucp_atomic_cswap32
UCP Communication routines, 116
ucp_atomic_cswap64
UCP Communication routines, 117
ucp_atomic_fadd32
UCP Communication routines, 113
ucp_atomic_fadd64
UCP Communication routines, 114
ucp_atomic_fetch_nb
UCP Communication routines, 129
ucp_atomic_fetch_op_t
UCP Communication routines, 96
ucp_atomic_op_nbx
UCP Communication routines, 107
ucp_atomic_op_t
UCP Communication routines, 94
ucp_atomic_post
UCP Communication routines, 128
ucp_atomic_post_op_t
UCP Communication routines, 96
ucp_atomic_swap32
UCP Communication routines, 115
ucp_atomic_swap64
UCP Communication routines, 116
ucp_cb_param_flags
UCP Endpoint, 77
ucp_cleanup
UCP Application Context, 22
ucp_config_modify
UCP Configuration, 134
ucp_config_print
UCP Configuration, 135
ucp_config_read
UCP Configuration, 134
ucp_config_release
UCP Configuration, 134
ucp_config_t
UCP Configuration, 133
ucp_conn_request_attr, 29
ucp_conn_request_attr_field
UCP Worker, 36
ucp_conn_request_attr_t
UCP Worker, 32
ucp_conn_request_h
UCP Endpoint, 74
ucp_conn_request_query
UCP Worker, 43
ucp_context_attr, 15
ucp_context_attr_field
UCP Application Context, 20
ucp_context_attr_t
UCP Application Context, 18

ucp_context_h
UCP Application Context, 18
ucp_context_print_info
UCP Application Context, 23
ucp_context_query
UCP Application Context, 23
ucp_datatype_attr, 137
ucp_datatype_attr_field
UCP Data type routines, 139
ucp_datatype_attr_t
UCP Data type routines, 139
ucp_datatype_t
UCP Communication routines, 91
ucp_disconnect_nb
UCP Endpoint, 83
ucp_dt_create_generic
UCP Data type routines, 140
ucp_dt_destroy
UCP Data type routines, 140
ucp_dt_iov, 137
ucp_dt_iov_t
UCP Data type routines, 138
ucp_dt_make_contig
UCP Data type routines, 138
ucp_dt_make_iov
UCP Data type routines, 138
ucp_dt_query
UCP Data type routines, 141
ucp_dt_type
UCP Data type routines, 139
ucp_ep_attr, 70
ucp_ep_attr_field
UCP Endpoint, 78
ucp_ep_attr_t
UCP Endpoint, 73
ucp_ep_close_flags_t
UCP Endpoint, 76
ucp_ep_close_mode
UCP Endpoint, 78
ucp_ep_close_nb
UCP Endpoint, 84
ucp_ep_close_nbx
UCP Endpoint, 79
ucp_ep_create
UCP Endpoint, 79
ucp_ep_destroy
UCP Endpoint, 83
ucp_ep_evaluate_perf
UCP Endpoint, 81
ucp_ep_evaluate_perf_attr_t, 70
ucp_ep_evaluate_perf_param_t, 70
ucp_ep_flush
UCP Endpoint, 83
ucp_ep_flush_nb
UCP Endpoint, 85
ucp_ep_flush_nbx
UCP Endpoint, 80
ucp_ep_h
UCP Endpoint, 74
ucp_ep_modify_nb
UCP Endpoint, 84
ucp_ep_params, 71
ucp_ep_params_field
UCP Endpoint, 75
ucp_ep_params_flags_field
UCP Endpoint, 76
ucp_ep_params_t
UCP Endpoint, 75
ucp_ep_perf_attr_field
UCP Endpoint, 77
ucp_ep_perf_attr_field_t
UCP Endpoint, 73
ucp_ep_perf_param_field
UCP Endpoint, 77
ucp_ep_perf_param_field_t
UCP Endpoint, 73
ucp_ep_print_info
UCP Endpoint, 80
ucp_ep_query
UCP Endpoint, 81
ucp_ep_rkey_unpack
UCP Memory routines, 60
ucp_err_handler, 90
ucp_err_handler_cb_t
UCP Communication routines, 91
ucp_err_handler_t
UCP Communication routines, 92
ucp_err_handling_mode_t
UCP Endpoint, 78
ucp_feature
UCP Application Context, 20
ucp_generic_dt_ops, 257
ucp_generic_dt_ops_t
UCP Data type routines, 139
ucp_get
UCP Communication routines, 111
ucp_get_nb
UCP Communication routines, 128
ucp_get_nbi
UCP Communication routines, 127
ucp_get_nbx
UCP Communication routines, 106
ucp_get_version
UCP Application Context, 21
ucp_get_version_string
UCP Application Context, 21
ucp_init
UCP Application Context, 21
ucp_lib_attr, 15
ucp_lib_attr_field
UCP Application Context, 20
ucp_lib_attr_t
UCP Application Context, 18
ucp_lib_query
UCP Application Context, 21
ucp_listener_accept_callback_t

UCP Worker, 33
ucp_listener_accept_handler, 31
ucp_listener_accept_handler_t
UCP Worker, 32
ucp_listener_attr, 29
ucp_listener_attr_field
UCP Worker, 36
ucp_listener_attr_t
UCP Worker, 32
ucp_listener_conn_callback_t
UCP Worker, 33
ucp_listener_conn_handler, 31
ucp_listener_conn_handler_t
UCP Worker, 34
ucp_listener_create
UCP Worker, 41
ucp_listener_destroy
UCP Worker, 42
ucp_listener_h
UCP Worker, 32
ucp_listener_params, 29
ucp_listener_params_field
UCP Worker, 35
ucp_listener_params_t
UCP Worker, 32
ucp_listener_query
UCP Worker, 42
ucp_listener_reject
UCP Worker, 43
ucp_mem_advice
UCP Memory routines, 54
ucp_mem_advice_t
UCP Memory routines, 52
ucp_mem_advise
UCP Memory routines, 59
ucp_mem_advise_params, 51
ucp_mem_advise_params_field
UCP Memory routines, 53
ucp_mem_advise_params_t
UCP Memory routines, 52
ucp_mem_attr, 51
ucp_mem_attr_field
UCP Memory routines, 55
ucp_mem_attr_t
UCP Memory routines, 53
ucp_mem_h
UCP Memory routines, 53
ucp_mem_map
UCP Memory routines, 56
ucp_mem_map_params, 50
ucp_mem_map_params_field
UCP Memory routines, 53
ucp_mem_map_params_t
UCP Memory routines, 52
ucp_mem_print_info
UCP Memory routines, 58
ucp_mem_query
UCP Memory routines, 58
ucp_mem_unmap
UCP Memory routines, 57
ucp_memh_buffer_release
UCP Memory routines, 60
ucp_memh_buffer_release_params, 51
ucp_memh_buffer_release_params_t
UCP Memory routines, 52
ucp_memh_pack
UCP Memory routines, 59
ucp_memh_pack_flags
UCP Memory routines, 55
ucp_memh_pack_params, 51
ucp_memh_pack_params_field
UCP Memory routines, 55
ucp_memh_pack_params_t
UCP Memory routines, 52
ucp_op_attr_t
UCP Communication routines, 94
ucp_params, 131
ucp_params_field
UCP Application Context, 19
ucp_params_t
UCP Configuration, 133
ucp_put
UCP Communication routines, 110
ucp_put_nb
UCP Communication routines, 126
ucp_put_nbi
UCP Communication routines, 125
ucp_put_nbx
UCP Communication routines, 105
ucp_req_attr_field
UCP Communication routines, 95
ucp_request_alloc
UCP Communication routines, 110
ucp_request_attr_t, 90
ucp_request_cancel
UCP Communication routines, 109
ucp_request_check_status
UCP Communication routines, 108
ucp_request_cleanup_callback_t
UCP Application Context, 19
ucp_request_free
UCP Communication routines, 110
ucp_request_init_callback_t
UCP Application Context, 19
ucp_request_is_completed
UCP Communication routines, 110
ucp_request_param_t, 16
ucp_request_param_t.cb, 17
ucp_request_param_t.recv_info, 18
ucp_request_query
UCP Communication routines, 97
ucp_request_release
UCP Endpoint, 83
ucp_request_test
UCP Endpoint, 83
ucp_rkey_buffer_release

UCP Memory routines, 62
ucp_rkey_compare
UCP Memory routines, 56
ucp_rkey_compare_params, 50
ucp_rkey_compare_params_t
UCP Memory routines, 52
ucp_rkey_destroy
UCP Memory routines, 61
ucp_rkey_h
UCP Memory routines, 52
ucp_rkey_pack
UCP Memory routines, 62
ucp_rkey_ptr
UCP Memory routines, 61
ucp_send_am_flags
UCP Worker, 37
ucp_send_callback_t
UCP Communication routines, 91
ucp_send_nbx_callback_t
UCP Communication routines, 91
ucp_stream_data_release
UCP Communication routines, 109
ucp_stream_poll_ep, 70
ucp_stream_poll_ep_t
UCP Endpoint, 73
ucp_stream_recv_callback_t
UCP Communication routines, 92
ucp_stream_recv_data_nb
UCP Communication routines, 102
ucp_stream_recv_flags_t
UCP Communication routines, 94
ucp_stream_recv_nb
UCP Communication routines, 119
ucp_stream_recv_nbx
UCP Communication routines, 101
ucp_stream_recv_nbx_callback_t
UCP Communication routines, 92
ucp_stream_recv_request_test
UCP Communication routines, 109
ucp_stream_send_nb
UCP Communication routines, 118
ucp_stream_send_nbx
UCP Communication routines, 99
ucp_stream_worker_poll
UCP Worker, 41
ucp_tag_message_h
UCP Communication routines, 90
ucp_tag_msg_recv_nb
UCP Communication routines, 125
ucp_tag_msg_recv_nbx
UCP Communication routines, 104
ucp_tag_probe_nb
UCP Communication routines, 103
ucp_tag_recv_callback_t
UCP Communication routines, 92
ucp_tag_recv_info, 16
ucp_tag_recv_info_t
UCP Application Context, 18
ucp_tag_recv_nb
UCP Communication routines, 123
ucp_tag_recv_nbr
UCP Communication routines, 124
ucp_tag_recv_nbx
UCP Communication routines, 103
ucp_tag_recv_nbx_callback_t
UCP Communication routines, 93
ucp_tag_recv_request_test
UCP Communication routines, 108
ucp_tag_send_nb
UCP Communication routines, 120
ucp_tag_send_nbr
UCP Communication routines, 121
ucp_tag_send_nbx
UCP Communication routines, 100
ucp_tag_send_sync_nb
UCP Communication routines, 122
ucp_tag_send_sync_nbx
UCP Communication routines, 101
ucp_tag_t
UCP Communication routines, 90
ucp_transport_entry_t, 72
ucp_transports_t, 73
ucp_wakeup_event_t
UCP Worker, 34
ucp_wakeup_event_types
UCP Worker, 37
ucp_worker_address_attr, 28
ucp_worker_address_attr_field
UCP Worker, 36
ucp_worker_address_attr_t
UCP Worker, 32
ucp_worker_address_flags_t
UCP Worker, 35
ucp_worker_address_query
UCP Worker, 40
ucp_worker_arm
UCP Wake-up routines, 66
ucp_worker_attr, 27
ucp_worker_attr_field
UCP Worker, 35
ucp_worker_attr_t
UCP Worker, 31
ucp_worker_create
UCP Worker, 38
ucp_worker_destroy
UCP Worker, 38
ucp_worker_fence
UCP Worker, 44
ucp_worker_flags_t
UCP Worker, 35
ucp_worker_flush
UCP Worker, 45
ucp_worker_flush_nb
UCP Worker, 47
ucp_worker_flush_nbx
UCP Worker, 44

ucp_worker_get_address
UCP Worker, 46
ucp_worker_get_efd
UCP Wake-up routines, 64
ucp_worker_h
UCP Worker, 33
ucp_worker_params, 27
ucp_worker_params_field
UCP Worker, 34
ucp_worker_params_t
UCP Worker, 31
ucp_worker_print_info
UCP Worker, 39
ucp_worker_progress
UCP Worker, 40
ucp_worker_query
UCP Worker, 39
ucp_worker_release_address
UCP Worker, 39
ucp_worker_set_am_handler
UCP Worker, 46
ucp_worker_set_am_recv_handler
UCP Worker, 43
ucp_worker_signal
UCP Wake-up routines, 67
ucp_worker_wait
UCP Wake-up routines, 65
ucp_worker_wait_mem
UCP Wake-up routines, 65
ucs_async_add_timer
UCS Communication Resource, 254
ucs_async_context_create
UCS Communication Resource, 255
ucs_async_context_destroy
UCS Communication Resource, 255
ucs_async_event_cb_t
UCS Communication Resource, 250
ucs_async_modify_handler
UCS Communication Resource, 255
ucs_async_poll
UCS Communication Resource, 256
ucs_async_remove_handler
UCS Communication Resource, 254
ucs_async_set_event_handler
UCS Communication Resource, 253
ucs_callbackq_flags
UCS Communication Resource, 251
ucs_memory_type
UCS Communication Resource, 251
ucs_memory_type_t
UCS Communication Resource, 251
ucs_sock_addr, 250
ucs_sock_addr_t
UCS Communication Resource, 250
ucs_status_ptr_t
UCS Communication Resource, 251
ucs_status_t
UCS Communication Resource, 252
ucs_thread_mode_t
UCS Communication Resource, 253
ucs_time_t
UCS Communication Resource, 251
uct_alloc_method_t
UCT Communication Context, 185
uct_allocated_memory, 193
uct_allocated_memory_t
UCT Memory Domain, 195
uct_am_callback_t
UCT Active messages, 204
uct_am_trace_type
UCT Active messages, 206
uct_am_trace_type_t
UCT Communication Resource, 162
uct_am_tracer_t
UCT Active messages, 205
uct_async_event_cb_t
UCT Communication Resource, 166
uct_cb_flags
UCT Communication Resource, 168
uct_cb_param_flags
UCT Communication Resource, 171
uct_cm_attr, 226
uct_cm_attr_field
UCT client-server operations, 232
uct_cm_attr_t
UCT Communication Resource, 162
uct_cm_client_ep_conn_notify
UCT client-server operations, 239
uct_cm_close
UCT client-server operations, 238
uct_cm_config_read
UCT client-server operations, 238
uct_cm_config_t
UCT Communication Resource, 160
uct_cm_ep_client_connect_args, 228
uct_cm_ep_client_connect_args_field
UCT client-server operations, 235
uct_cm_ep_client_connect_args_t
UCT client-server operations, 230
uct_cm_ep_client_connect_callback_t
UCT client-server operations, 231
uct_cm_ep_priv_data_pack_args, 227
uct_cm_ep_priv_data_pack_args_field
UCT client-server operations, 233
uct_cm_ep_priv_data_pack_args_t
UCT client-server operations, 229
uct_cm_ep_priv_data_pack_callback_t
UCT client-server operations, 231
uct_cm_ep_resolve_args, 227
uct_cm_ep_resolve_args_field
UCT client-server operations, 234
uct_cm_ep_resolve_args_t
UCT client-server operations, 229
uct_cm_ep_resolve_callback_t
UCT client-server operations, 232
uct_cm_ep_server_conn_notify_args, 229

uct_cm_ep_server_conn_notify_args_field
UCT client-server operations, 235
uct_cm_ep_server_conn_notify_args_t
UCT client-server operations, 230
uct_cm_ep_server_conn_notify_callback_t
UCT client-server operations, 230
uct_cm_h
UCT Communication Resource, 163
uct_cm_listener_conn_request_args, 228
uct_cm_listener_conn_request_args_field
UCT client-server operations, 234
uct_cm_listener_conn_request_args_t
UCT client-server operations, 229
uct_cm_listener_conn_request_callback_t
UCT client-server operations, 230
uct_cm_open
UCT client-server operations, 237
uct_cm_query
UCT client-server operations, 238
uct_cm_remote_data, 227
uct_cm_remote_data_field
UCT client-server operations, 234
uct_cm_remote_data_t
UCT client-server operations, 229
uct_cm_t
UCT Communication Resource, 162
uct_completion, 158
uct_completion_callback_t
UCT Communication Resource, 164
uct_completion_t
UCT Communication Resource, 161
uct_completion_update_status
UCT Communication Resource, 184
uct_component_attr, 150
uct_component_attr_field
UCT Communication Resource, 166
uct_component_attr_t
UCT Communication Resource, 159
uct_component_h
UCT Communication Resource, 160
uct_component_query
UCT Communication Resource, 172
uct_config_get
UCT Communication Context, 187
uct_config_modify
UCT Communication Context, 189
uct_config_release
UCT Communication Resource, 174
uct_conn_request_h
UCT Communication Resource, 163
uct_device_addr_t
UCT Communication Resource, 162
uct_device_type_t
UCT Communication Resource, 167
uct_ep_addr_t
UCT Communication Resource, 162
uct_ep_am_bcopy
UCT Active messages, 208
uct_ep_am_short
UCT Active messages, 207
uct_ep_am_short_iov
UCT Active messages, 208
uct_ep_am_zcopy
UCT Active messages, 208
uct_ep_atomic32_fetch
UCT Atomic operations, 214
uct_ep_atomic32_post
UCT Atomic operations, 213
uct_ep_atomic64_fetch
UCT Atomic operations, 214
uct_ep_atomic64_post
UCT Atomic operations, 214
uct_ep_atomic_cswap32
UCT Atomic operations, 213
uct_ep_atomic_cswap64
UCT Atomic operations, 213
uct_ep_attr_t
UCT Communication Resource, 161
uct_ep_check
UCT Communication Resource, 177
uct_ep_connect
UCT client-server operations, 236
uct_ep_connect_params, 226
uct_ep_connect_params_field
UCT client-server operations, 233
uct_ep_connect_params_t
UCT Communication Resource, 162
uct_ep_connect_to_ep
UCT Communication Resource, 180
uct_ep_create
UCT Communication Resource, 179
uct_ep_destroy
UCT Communication Resource, 180
uct_ep_disconnect
UCT client-server operations, 237
uct_ep_disconnect_cb_t
UCT client-server operations, 231
uct_ep_fence
UCT Communication Resource, 183
uct_ep_flush
UCT Communication Resource, 182
uct_ep_get_address
UCT Communication Resource, 180
uct_ep_get_bcopy
UCT Remote memory access operations, 211
uct_ep_get_short
UCT Remote memory access operations, 211
uct_ep_get_zcopy
UCT Remote memory access operations, 211
uct_ep_h
UCT Communication Resource, 160
uct_ep_params, 155
uct_ep_params_field
UCT Communication Resource, 169
uct_ep_params_t
UCT Communication Resource, 162

uct_ep_pending_add
UCT Communication Resource, 182
uct_ep_pending_purge
UCT Communication Resource, 182
uct_ep_put_bcopy
UCT Remote memory access operations, 210
uct_ep_put_short
UCT Remote memory access operations, 210
uct_ep_put_zcopy
UCT Remote memory access operations, 210
uct_ep_tag_eager_bcopy
UCT Tag matching operations, 218
uct_ep_tag_eager_short
UCT Tag matching operations, 217
uct_ep_tag_eager_zcopy
UCT Tag matching operations, 218
uct_ep_tag_rndv_cancel
UCT Tag matching operations, 220
uct_ep_tag_rndv_request
UCT Tag matching operations, 220
uct_ep_tag_rndv_zcopy
UCT Tag matching operations, 219
uct_error_handler_t
UCT Communication Resource, 164
uct_flush_flags
UCT Communication Resource, 167
uct_iface_accept
UCT client-server operations, 236
uct_iface_addr_t
UCT Communication Resource, 162
uct_iface_attr, 151
uct_iface_attr.cap, 151
uct_iface_attr.cap.am, 152
uct_iface_attr.cap.atomic32, 153
uct_iface_attr.cap.atomic64, 153
uct_iface_attr.cap.get, 152
uct_iface_attr.cap.put, 152
uct_iface_attr.cap.tag, 153
uct_iface_attr.cap.tag.eager, 153
uct_iface_attr.cap.tag.recv, 153
uct_iface_attr.cap.tag.rndv, 153
uct_iface_attr_t
UCT Communication Resource, 161
uct_iface_close
UCT Communication Resource, 175
uct_iface_config_t
UCT Communication Resource, 160
uct_iface_event_arm
UCT Communication Resource, 178
uct_iface_event_fd_get
UCT Communication Resource, 177
uct_iface_event_types
UCT Communication Resource, 167
uct_iface_feature
UCT Communication Resource, 170
uct_iface_fence
UCT Communication Resource, 181
uct_iface_flush
UCT Communication Resource, 181
uct_iface_get_address
UCT Communication Resource, 176
uct_iface_get_device_address
UCT Communication Resource, 176
uct_iface_h
UCT Communication Resource, 160
uct_iface_is_reachable
UCT Communication Resource, 177
uct_iface_mem_alloc
UCT Communication Resource, 178
uct_iface_mem_free
UCT Communication Resource, 179
uct_iface_open
UCT Communication Resource, 175
uct_iface_open_mode
UCT Communication Resource, 168
uct_iface_params, 153
uct_iface_params.mode, 154
uct_iface_params.mode.device, 155
uct_iface_params.mode.sockaddr, 155
uct_iface_params_field
UCT Communication Resource, 169
uct_iface_params_t
UCT Communication Resource, 161
uct_iface_progress
UCT Communication Resource, 184
uct_iface_progress_disable
UCT Communication Resource, 184
uct_iface_progress_enable
UCT Communication Resource, 183
uct_iface_query
UCT Communication Resource, 176
uct_iface_reject
UCT client-server operations, 236
uct_iface_release_desc
UCT Active messages, 207
uct_iface_set_am_handler
UCT Active messages, 206
uct_iface_set_am_tracer
UCT Active messages, 207
uct_iface_tag_recv_cancel
UCT Tag matching operations, 221
uct_iface_tag_recv_zcopy
UCT Tag matching operations, 221
uct_iov, 158
uct_iov_t
UCT Communication Resource, 163
uct_listener_attr, 226
uct_listener_attr_field
UCT client-server operations, 233
uct_listener_attr_t
UCT Communication Resource, 163
uct_listener_create
UCT client-server operations, 239
uct_listener_destroy
UCT client-server operations, 239
uct_listener_h

UCT Communication Resource, 163
uct_listener_params, 226
uct_listener_params_field
UCT client-server operations, 233
uct_listener_params_t
UCT Communication Resource, 163
uct_listener_query
UCT client-server operations, 240
uct_listener_reject
UCT client-server operations, 240
uct_md_attr, 192
uct_md_attr.cap, 192
uct_md_attr_t
UCT Communication Resource, 161
uct_md_close
UCT Communication Resource, 173
uct_md_config_read
UCT Memory Domain, 201
uct_md_config_t
UCT Communication Resource, 160
uct_md_detect_memory_type
UCT Memory Domain, 200
uct_md_h
UCT Communication Resource, 160
uct_md_iface_config_read
UCT Communication Resource, 174
uct_md_is_sockaddr_accessible
UCT Memory Domain, 201
uct_md_mem_advise
UCT Memory Domain, 199
uct_md_mem_attr, 192
uct_md_mem_attr_field
UCT Memory Domain, 197
uct_md_mem_attr_field_t
UCT Memory Domain, 194
uct_md_mem_attr_t
UCT Memory Domain, 194
uct_md_mem_dereg
UCT Memory Domain, 199
uct_md_mem_flags
UCT Memory Domain, 196
uct_md_mem_query
UCT Memory Domain, 198
uct_md_mem_reg
UCT Memory Domain, 199
uct_md_mkey_pack
UCT Memory Domain, 202
uct_md_open
UCT Communication Resource, 172
uct_md_ops_t
UCT Communication Resource, 161
uct_md_query
UCT Memory Domain, 198
uct_md_query_tl_resources
UCT Communication Resource, 173
uct_md_resource_desc, 150
uct_md_resource_desc_t
UCT Communication Resource, 159
uct_md_t
UCT Communication Resource, 162
uct_mem_advice_t
UCT Memory Domain, 197
uct_mem_alloc
UCT Memory Domain, 200
uct_mem_alloc_params_field_t
UCT Memory Domain, 197
uct_mem_alloc_params_t, 193
uct_mem_alloc_params_t.mds, 194
uct_mem_free
UCT Memory Domain, 201
uct_mem_h
UCT Communication Resource, 160
uct_msg_flags
UCT Active messages, 205
uct_pack_callback_t
UCT Communication Resource, 165
uct_pending_callback_t
UCT Communication Resource, 164
uct_pending_purge_callback_t
UCT Communication Resource, 165
uct_pending_req, 158
uct_pending_req_t
UCT Communication Resource, 161
uct_progress_types
UCT Communication Resource, 168
uct_query_components
UCT Communication Resource, 171
uct_release_component_list
UCT Communication Resource, 171
uct_release_tl_resource_list
UCT Communication Resource, 174
uct_rkey_bundle, 193
uct_rkey_bundle_t
UCT Memory Domain, 195
uct_rkey_ctx_h
UCT Communication Resource, 161
uct_rkey_ptr
UCT Memory Domain, 203
uct_rkey_release
UCT Memory Domain, 203
uct_rkey_t
UCT Communication Resource, 160
uct_rkey_unpack
UCT Memory Domain, 202
uct_sockaddr_accessibility_t
UCT Memory Domain, 195
uct_sockaddr_conn_request_callback_t
UCT client-server operations, 230
uct_tag_context, 257
completed_cb, 258
priv, 259
rndv_cb, 258
tag_consumed_cb, 258
uct_tag_context_t
UCT Communication Resource, 163
uct_tag_t

UCT Communication Resource, 163
uct_tag_unexp_eager_cb_t
UCT Tag matching operations, 215
uct_tag_unexp_rndv_cb_t
UCT Tag matching operations, 216
uct_tl_resource_desc, 150
uct_tl_resource_desc_t
UCT Communication Resource, 159
uct_unpack_callback_t
UCT Communication Resource, 165
uct_worker_cb_id_t
UCT Communication Resource, 163
uct_worker_create
UCT Communication Context, 186
uct_worker_destroy
UCT Communication Context, 186
uct_worker_h
UCT Communication Resource, 161
uct_worker_progress
UCT Communication Context, 189
uct_worker_progress_register_safe
UCT Communication Context, 186
uct_worker_progress_unregister_safe
UCT Communication Context, 187
Unified Communication Protocol (UCP) API, 13
Unified Communication Services (UCS) API, 248
Unified Communication Transport (UCT) API, 144
unpack
UCP Data type routines, 142