BMW IDCevo KT :: MDIO and PHY framework

Management Data Input/Output, or MDIO, is a 2-wire serial bus that is used to manage PHYs or physical layer devices in media access controllers (MACs) in Gigabit Ethernet equipment.

Why do we need MDIO?

- Standardized and easy approach to access PHY devices which existing protocols could not satisfy.
- Faster than existing protocols like I2C. The MDIO interface clock (MDC) supports frequency up to 2.5MHz.

Clause 22

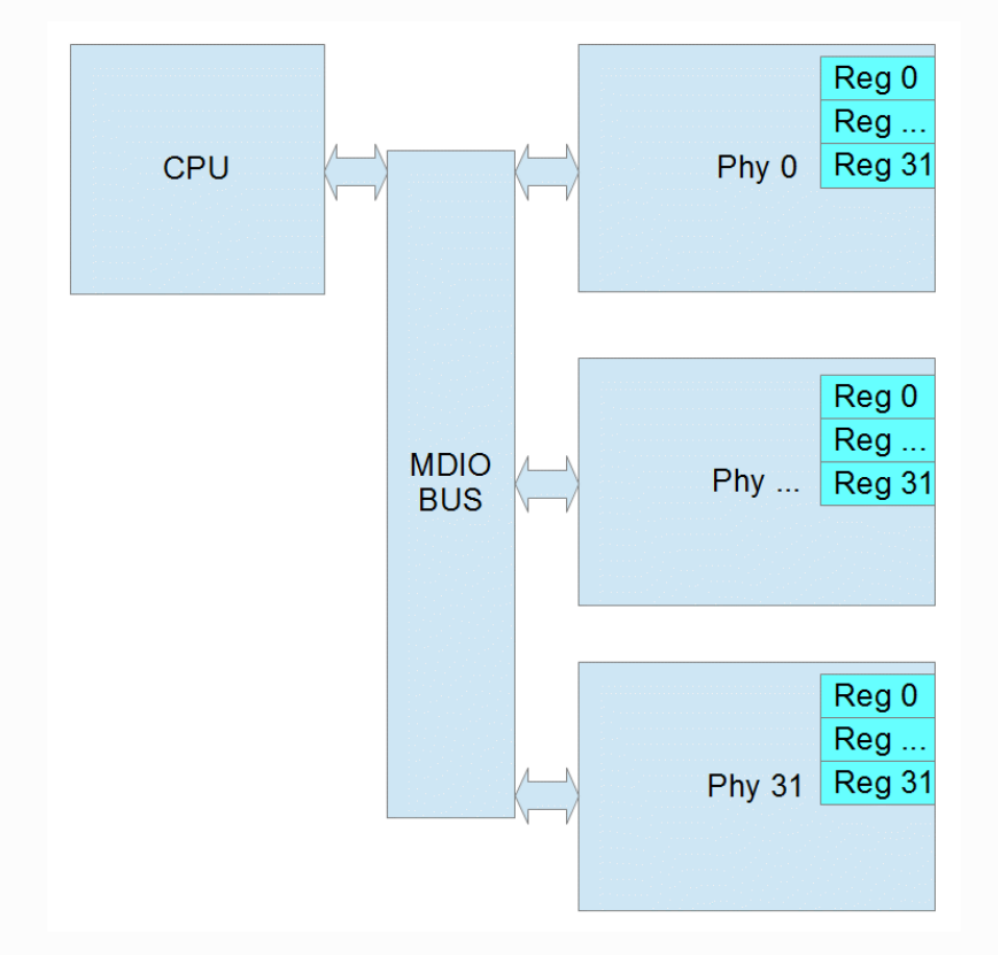
MDIO was originally defined in Clause 22 of IEEE RFC802.3. In the original specification, a single MDIO interface is able to access up to 32 registers in 32 different PHY devices.

Data structure

PREAMBLE	ST	OP	PHY_ADR	REG_ADR	TA	DATA	IDLE
32 bit (1111.....1111)	2 bit (01)	2 bit (01/10)	5 bit	5 bit	2 bit	16 bit	Z

Key Values

- Phy Address 5 bits (0 – 31 decimal)
- Register address 5 bits (0 – 31 decimal) or (0 – 1F hex)
- Data 16 bits



Clause 45

As Ethernet Phys became more complicated and supported different speeds and connections, IEEE 802.3 Clause 45 was added. Because the Register Address is now 16 bits, each read/write takes at 2 operations.

The read and write operation happens in 2 stages

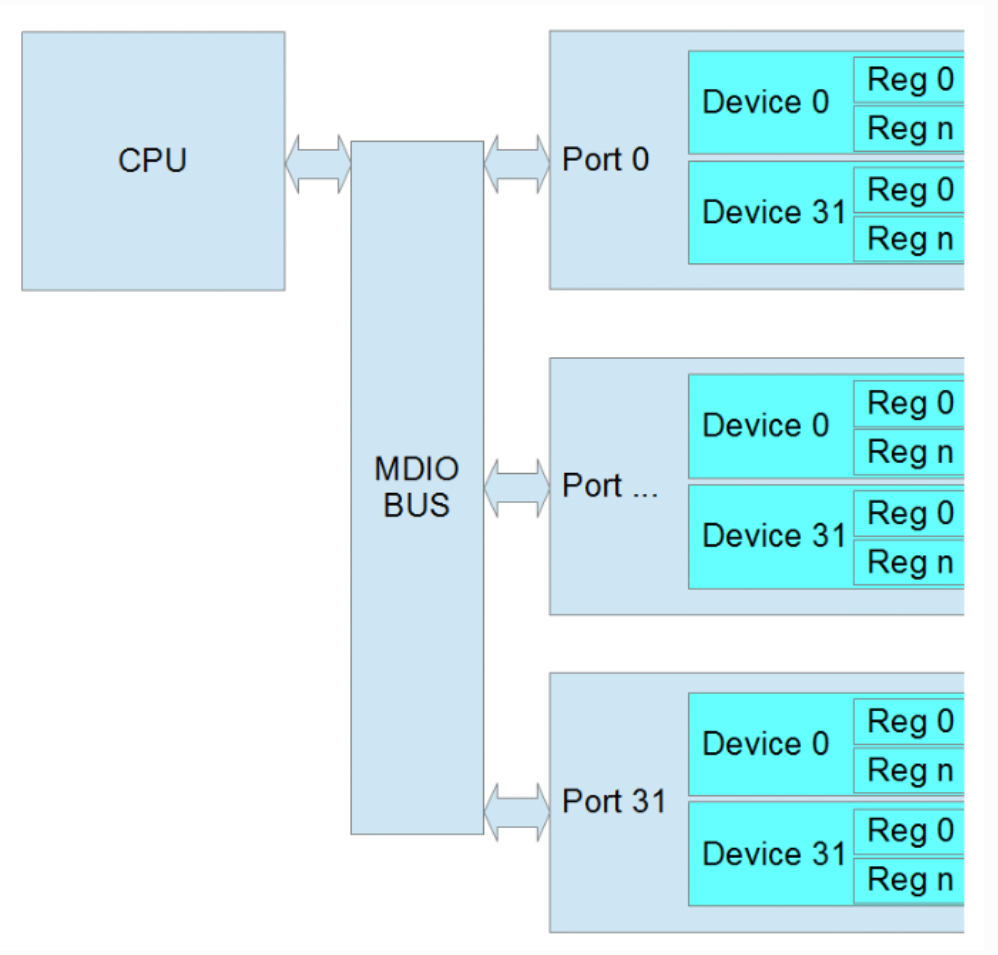
1. The first operation is always writing the Register Address that you want to use in the next operation.
2. The second is the actual read or write. There is also a special read that increments the address after each read which allows you to write a starting address and then read a whole block of registers.

Data structure

PREAMBLE	ST	OP	PHY_ADR	REG_ADR	TA	DATA	IDLE
32 bit (1111.....1111)	2 bit (01)	2 bit (01/10)	5 bit	5 bit	2 bit	16 bit	Z

Key values

- Port 5 bits (this is equivalent to the Phy Address)
- Device 5 bits (this is similar to the page)
- Register address 16 bits (this allows 65536 registers in each device)
- Data 16 bits



Phy Driver

Code flow

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Match
[    3.305365][    T1] Harman function q222x_match_phy_device
[    3.305373][    T1] CPU: 1 PID: 1 Comm: swapper/0 Tainted: G        W
[    3.305580][    T1] Hardware name: BMW IDCEvo (v920-EVT1 SP25-PHY B3) Linux S
[    3.305585][    T1] Call trace:
[    3.305588][    T1]  dump_backtrace+0x0/0x1c0
[    3.305599][    T1]  show_stack+0x18/0x28
[    3.305604][    T1]  dump_stack_lvl+0x68/0x84
[    3.305610][    T1]  dump_stack+0x18/0x34
[    3.305613][    T1]  q222x_match_phy_device+0x2c/0x6c
[    3.305619][    T1]  phy_bus_match+0x20/0xa0
[    3.305625][    T1]  mdio_bus_match+0x50/0x60
[    3.305630][    T1]  __device_attach_driver+0x38/0xe0
[    3.305637][    T1]  bus_for_each_drv+0x78/0xc8
[    3.305641][    T1]  __device_attach+0xf0/0x150
[    3.305646][    T1]  device_initial_probe+0x14/0x20
[    3.305650][    T1]  bus_probe_device+0x9c/0xa8
[    3.305655][    T1]  device_add+0x3c4/0x888
[    3.305659][    T1]  phy_device_register+0x58/0xa0
[    3.305663][    T1]  fwnode_mdiobus_phy_device_register+0xb8/0x140
[    3.305668][    T1]  fwnode_mdiobus_register_phy+0x160/0x1d8
[    3.305672][    T1]  of_mdiobus_register+0x13c/0x380
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[    3.305676][    T1]  stmmac_mdio_register+0x12c/0x2a8
[    3.305682][    T1]  stmmac_dvr_probe+0xc34/0xee8
[    3.305686][    T1]  dwmac_sxgmac_probe+0x804/0xbf0
[    3.305690][    T1]  platform_probe+0x68/0xd8
[    3.305694][    T1]  really_probe+0xb8/0x300
[    3.305699][    T1]  __driver_probe_device+0x78/0xe0
[    3.305704][    T1]  driver_probe_device+0x40/0x110
[    3.305709][    T1]  __driver_attach+0x70/0x108
[    3.305713][    T1]  bus_for_each_dev+0x70/0xc0
[    3.305718][    T1]  driver_attach+0x24/0x30
[    3.305722][    T1]  bus_add_driver+0x150/0x1f8
[    3.305727][    T1]  driver_register+0x64/0x120
[    3.305732][    T1]  __platform_driver_register+0x28/0x38
[    3.305736][    T1]  dwmac_sxgmac_driver_init+0x1c/0x28
[    3.305741][    T1]  do_one_initcall+0x48/0x288
[    3.305746][    T1]  kernel_init_freeable+0x24c/0x2dc
[    3.305752][    T1]  kernel_init+0x2c/0x140
[    3.305758][    T1]  ret_from_fork+0x10/0x20


Reset
[    4.883216][  T353] Harman function q222x_soft_reset
[    4.883222][  T353] CPU: 2 PID: 353 Comm: systemd-network Tainted: G        W
[    4.884424][  T353] Hardware name: BMW IDCEvo (v920-EVT1 SP25-PHY B3) Linux S
[    4.884430][  T353] Call trace:
[    4.884434][  T353]  dump_backtrace+0x0/0x1c0
[    4.884445][  T353]  show_stack+0x18/0x28
[    4.884451][  T353]  dump_stack_lvl+0x68/0x84
[    4.884459][  T353]  dump_stack+0x18/0x34
[    4.884462][  T353]  q222x_soft_reset+0x30/0xa4
[    4.884467][  T353]  phy_init_hw+0x34/0xc0
[    4.884473][  T353]  phy_attach_direct+0x150/0x2f0
[    4.884478][  T353]  phylink_fwnode_phy_connect+0x7c/0x128
[    4.884482][  T353]  phylink_of_phy_connect+0x1c/0x28
[    4.884486][  T353]  stmmac_open+0xe4/0x458
[    4.884490][  T353]  __dev_open+0xe4/0x190
[    4.884496][  T353]  __dev_change_flags+0x19c/0x1f8
[    4.884502][  T353]  dev_change_flags+0x24/0x68
[    4.884506][  T353]  do_setlink+0x614/0xd38
[    4.884512][  T353]  rtnl_setlink+0xe8/0x190
[    4.884516][  T353]  rtnetlink_rcv_msg+0x11c/0x338
[    4.884521][  T353]  netlink_rcv_skb+0x58/0x118
[    4.884525][  T353]  rtnetlink_rcv+0x18/0x28
[    4.884530][  T353]  netlink_unicast+0x1bc/0x278
[    4.884534][  T353]  netlink_sendmsg+0x1dc/0x420
[    4.884537][  T353]  sock_sendmsg+0x4c/0x58
[    4.884542][  T353]  __sys_sendto+0xd0/0x140
[    4.884545][  T353]  __arm64_sys_sendto+0x28/0x38
[    4.884549][  T353]  invoke_syscall+0x44/0x108
[    4.884554][  T353]  el0_svc_common.constprop.0+0xcc/0xf0
[    4.884558][  T353]  do_el0_svc+0x24/0x88
[    4.884563][  T353]  el0_svc+0x20/0x60
[    4.884567][  T353]  el0t_64_sync_handler+0xb0/0xb8
[    4.884571][  T353]  el0t_64_sync+0x1a4/0x1a8

Init sequence
[    4.891670][  T353] Harman function q222x_config_init
[    4.891685][  T353] CPU: 2 PID: 353 Comm: systemd-network Tainted: G        W
[    4.891879][  T353] Hardware name: BMW IDCEvo (v920-EVT1 SP25-PHY B3) Linux S
[    4.891884][  T353] Call trace:
[    4.891887][  T353]  dump_backtrace+0x0/0x1c0
[    4.891897][  T353]  show_stack+0x18/0x28
[    4.891903][  T353]  dump_stack_lvl+0x68/0x84
[    4.891909][  T353]  dump_stack+0x18/0x34
[    4.891913][  T353]  q222x_config_init+0x48/0x2bc
[    4.891918][  T353]  phy_init_hw+0x68/0xc0
[    4.891924][  T353]  phy_attach_direct+0x150/0x2f0
[    4.891929][  T353]  phylink_fwnode_phy_connect+0x7c/0x128
[    4.891933][  T353]  phylink_of_phy_connect+0x1c/0x28
[    4.891936][  T353]  stmmac_open+0xe4/0x458
[    4.891940][  T353]  __dev_open+0xe4/0x190
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[    4.891947][  T353]  __dev_change_flags+0x19c/0x1f8
[    4.891952][  T353]  dev_change_flags+0x24/0x68
[    4.891957][  T353]  do_setlink+0x614/0xd38
[    4.891962][  T353]  rtnl_setlink+0xe8/0x190
[    4.891967][  T353]  rtnetlink_rcv_msg+0x11c/0x338
[    4.891972][  T353]  netlink_rcv_skb+0x58/0x118
[    4.891976][  T353]  rtnetlink_rcv+0x18/0x28
[    4.891981][  T353]  netlink_unicast+0x1bc/0x278

Reset
[    4.896129][  T353] Harman function q222x_soft_reset
[    4.897345][  T353] Call trace:
[    4.897350][  T353]  dump_backtrace+0x0/0x1c0
[    4.897362][  T353]  show_stack+0x18/0x28
[    4.897370][  T353]  dump_stack_lvl+0x68/0x84
[    4.897379][  T353]  dump_stack+0x18/0x34
[    4.897385][  T353]  q222x_soft_reset+0x30/0xa4
[    4.897392][  T353]  q222x_config_init+0x1fc/0x2bc
[    4.897398][  T353]  phy_init_hw+0x68/0xc0
[    4.897406][  T353]  phy_attach_direct+0x150/0x2f0
[    4.897412][  T353]  phylink_fwnode_phy_connect+0x7c/0x128
[    4.897416][  T353]  phylink_of_phy_connect+0x1c/0x28
[    4.897419][  T353]  stmmac_open+0xe4/0x458
[    4.897423][  T353]  __dev_open+0xe4/0x190
[    4.897430][  T353]  __dev_change_flags+0x19c/0x1f8
[    4.897435][  T353]  dev_change_flags+0x24/0x68
[    4.897440][  T353]  do_setlink+0x614/0xd38
[    4.897445][  T353]  rtnl_setlink+0xe8/0x190
[    4.897450][  T353]  rtnetlink_rcv_msg+0x11c/0x338
[    4.897455][  T353]  netlink_rcv_skb+0x58/0x118
[    4.897459][  T353]  rtnetlink_rcv+0x18/0x28
[    4.897463][  T353]  netlink_unicast+0x1bc/0x278
[    4.897467][  T353]  netlink_sendmsg+0x1dc/0x420
[    4.897471][  T353]  sock_sendmsg+0x4c/0x58
[    4.897476][  T353]  __sys_sendto+0xd0/0x140
[    4.897480][  T353]  __arm64_sys_sendto+0x28/0x38
[    4.897484][  T353]  invoke_syscall+0x44/0x108
[    4.897489][  T353]  el0_svc_common.constprop.0+0xcc/0xf0
[    4.897493][  T353]  do_el0_svc+0x24/0x88
[    4.897498][  T353]  el0_svc+0x20/0x60
[    4.897503][  T353]  el0t_64_sync_handler+0xb0/0xb8
[    4.897507][  T353]  el0t_64_sync+0x1a4/0x1a8

Initial Read status
[    5.049352][  T271] Harman function q222x_read_status
[    5.050170][  T271] Hardware name: BMW IDCEvo (v920-EVT1 SP25-PHY B3) Linux S
[    5.050175][  T271] Workqueue: events_power_efficient phylink_resolve
[    5.050181][  T271] Call trace:
[    5.050184][  T271]  dump_backtrace+0x0/0x1c0
[    5.050189][  T271]  show_stack+0x18/0x28
[    5.050194][  T271]  dump_stack_lvl+0x68/0x84
[    5.050198][  T271]  dump_stack+0x18/0x34
[    5.050202][  T271]  q222x_read_status+0x60/0x1b0
[    5.050206][  T271]  phy_init_eee+0x50/0x180
[    5.050210][  T271]  sxgmac_mac_link_up+0x2b4/0x300
[    5.050215][  T271]  phylink_resolve+0x174/0x470
[    5.050219][  T271]  process_one_work+0x1d0/0x498
[    5.050223][  T271]  worker_thread+0x4c/0x400
[    5.050227][  T271]  kthread+0x144/0x158
[    5.050230][  T271]  ret_from_fork+0x10/0x20

Read Status
[   40.896032][  T271] Harman function q222x_read_status
[   40.896053][  T271] CPU: 2 PID: 271 Comm: kworker/2:3 Tainted: G        W
[   40.896418][  T271] Hardware name: BMW IDCEvo (v920-EVT1 SP25-PHY B3) Linux S
[   40.896423][  T271] Workqueue: events_power_efficient phy_state_machine
[   40.896438][  T271] Call trace:
[   40.896441][  T271]  dump_backtrace+0x0/0x1c0
[   40.896452][  T271]  show_stack+0x18/0x28
[   40.896457][  T271]  dump_stack_lvl+0x68/0x84
[   40.896462][  T271]  dump_stack+0x18/0x34
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[   40.896466][  T271]  q222x_read_status+0x60/0x1b0
[   40.896471][  T271]  phy_check_link_status+0x48/0xc0
[   40.896475][  T271]  phy_state_machine+0x1a0/0x220
[   40.896479][  T271]  process_one_work+0x1d0/0x498
[   40.896484][  T271]  worker_thread+0x4c/0x400
[   40.896488][  T271]  kthread+0x144/0x158
[   40.896492][  T271]  ret_from_fork+0x10/0x20
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