

softMC Training – Module 6

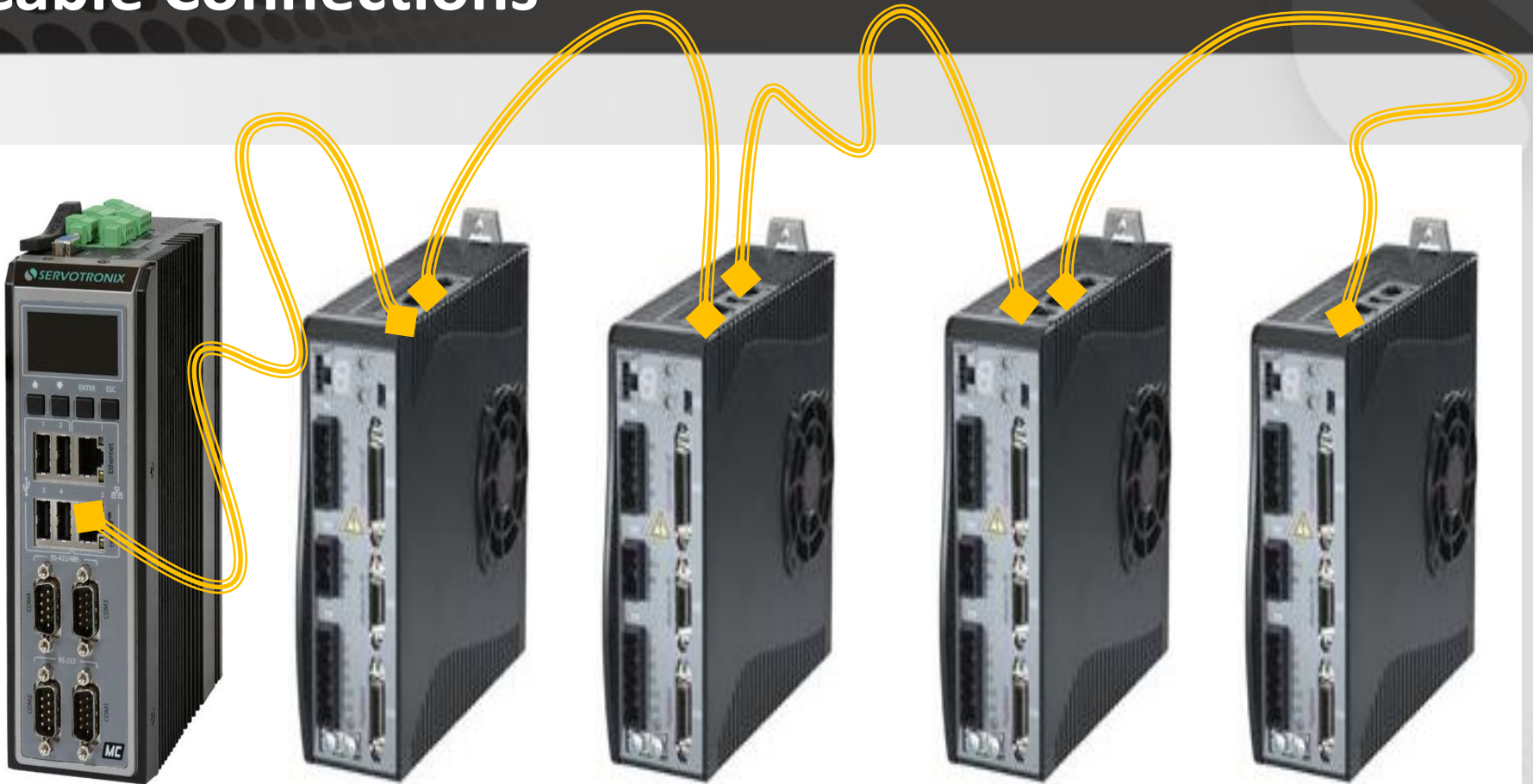
# Motion Bus



# Contents

- Motion bus in reference to: EtherCAT and CANopen
- Motion bus connections:
  - Cable connections
  - Drive mapping
  - IO module mapping
- Software module
  - Motion Bus libraries and Motion Bus setup programs
  - I/O modules can be connected to the motion bus (may require additional libraries)
- Cyclic Synchronous Position Mode (default)
- Troubleshooting

# Cable Connections



MC:EtherCAT → CDHD:C5 and CDHD:C6 → CDHD:C5 and CDHD:C6 → CDHD:C5 ...

# EtherCAT Slave Communication States

INIT

- Drive power up. Cable not connected.

PREOP

- EtherCAT cable connected. Yellow LED turned on.

SAFEOP

- Communication with MC established.  
Both LEDs blinking fast.

OP

- Cycle-time set. PDOs mapped. System is running.

# EtherCAT Operation Modes (CiA 402)

- Set by user in Object 6060h

**(1) Profile Position Mode**

**(3) Profile Velocity Mode**

**(4) Profile Torque Mode**

**(6) Homing Mode**

**(7) Interpolated Position Mode**

**(8) Cyclic Synchronous Position Mode**

**(9) Cyclic Synchronous Velocity Mode**

**(10) Cyclic Synchronous Torque Mode**

# SDO and PDO

- **SDOs** (Service Data Objects)
  - Used for direct access devices
- **PDOs** (Process Data Objects)
  - Cyclic data transferred every motion bus sample
- Position resolution (MC-Basic global variable)
  - **Pos\_Units[\*]** array of integers defining the number of units per motor revolution (pitch for linear motors).  
*This array is assigned by EC\_SETUP.PRG with values retrieved from CDHD.*
- **Basic EtherCAT interface functions:**
  - **EC\_SDO\_WRITE**
  - **EC\_SDO\_READ**
  - **EC\_SDO\_READ\_DOUBLE**
  - **EC\_SDO\_WRITE\_DOUBLE**
  - **EC\_SDO\_READ\_STRING**
  - **EC\_PDO\_READ**
  - **EC\_PDO\_WRITE**

# SDO and PDO

- **SDOs** (Service Data Objects)
  - Acyclic (on demand) reading/writing data objects in the drive.
  - Data is explicitly checked on write and ACKed or NAKed.
  - Optional retry if data lost.
- **PDOs** (Process Data Objects)
  - Cyclic exchange of predefined number of objects.
  - Cyclic data transferred every motion bus sample.
  - No explicit handshake.
  - Incorrect data – drive either ignores or issues general error
  - No retry. Drive or motion controller handles (extrapolates) missing data.



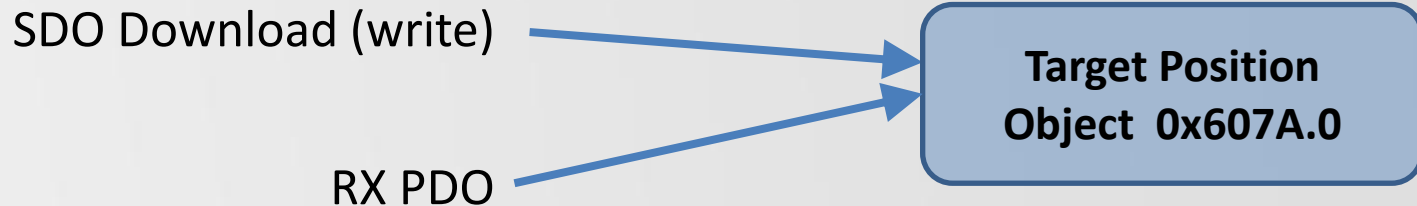
# Typical Default PDO Mapping of CDHD

TXPDO		Size in bits	Mapping in Motion Controller
0x6041:00	Status Word	16	axis.dstat
0x6061:00	Modes of Operation Display	8	
0x6077:00	Torque Actual Value	16	
0x6064:00	Position Actual Value	32	axis.cfb
0x606c:00	Velocity Actual Value	32	
0x6078:00	Current Actual Value	16	axis.ctfb
0x6074:00	Torque Demand Value	16	axis.ctdcmnd
0x20f2:00	Analog Input 1	16	
0x20f9:00	Analog Input 2	16	
0x60fd:00	Digital inputs	32	sys.din
0x20b6:00	Manuf_Spec_Machine_HW_Position_External_Command	32/	
0x60f4:00	Following Error Actual Value	32	
RXPDO			
0x6040:00	Control Word	16	axis.dcon
0x6060:00	Modes of Operation	8	
0x607a:00	Target Position	32	axis.ccmd
0x6081:00	Profile Velocity	32	axis.vcmd(*)
0x60ff:00	Target Velocity	32	axis.vcmd(*)
0x60b1:00	Velocity Offset	32	
0x60b2:00	Torque Offset	16	
0x6071:00	Target Torque	16	axis.ctcmd
0x60fe:01	Digital Output	32	sys.dout



# SDO and PDO

- The same variable (object) in the node (drive) can be accessed over SDO and PDO at the same time.
- Both SDO and PDO access the same variable in the drive.

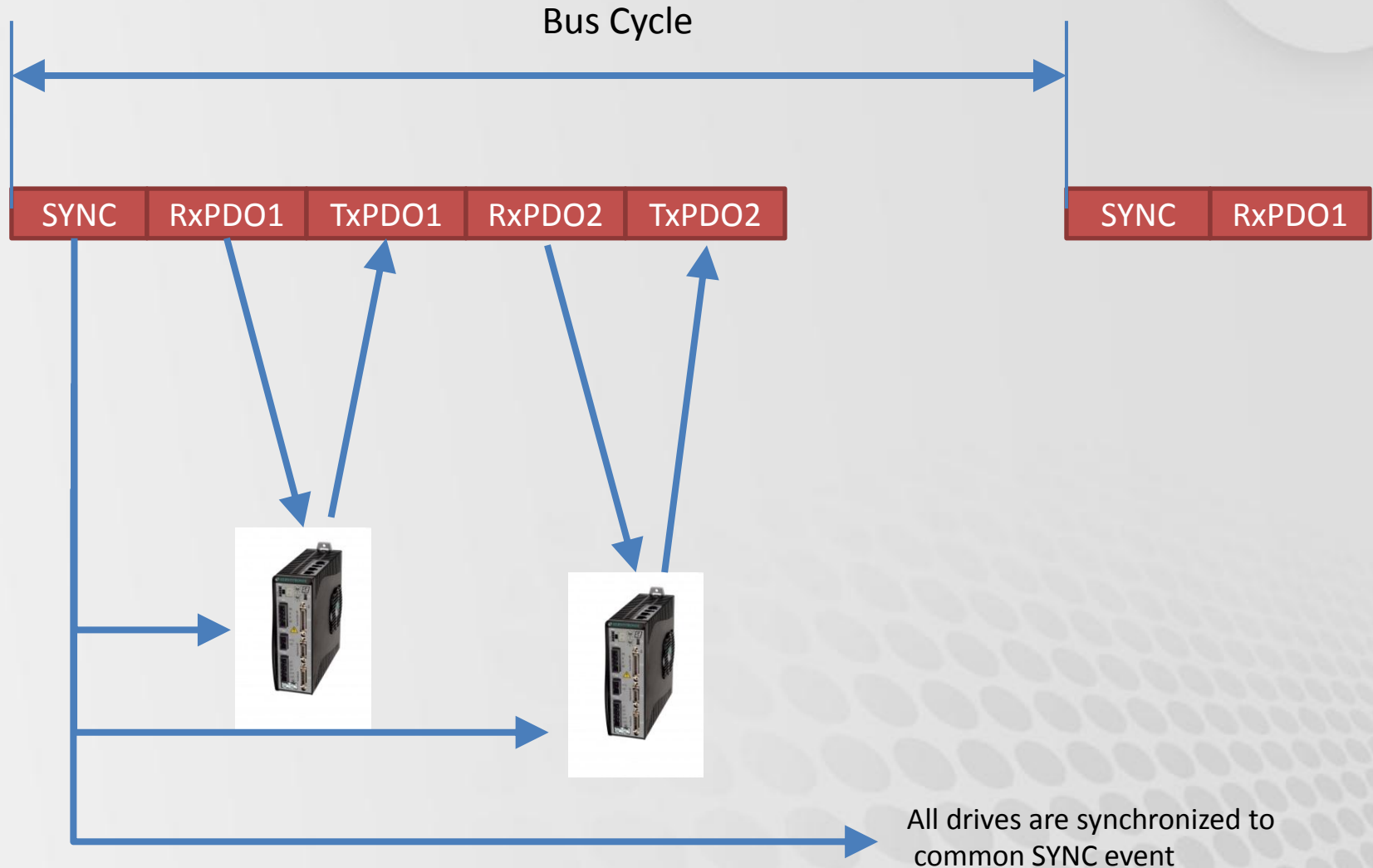


- **Important Note:**  
Writing data over both SDO and PDO can lead to inconsistent behavior, since data is constantly being overwritten by PDO

# SDO Read/Write

- **?EC\_SDO\_READ**(*<slave address>*, *<SDO index>*, *<SDO sub-index>*)
  - *<slave address>* drive address (1,2,3, ...)
  - *<SDO index>* object index (0x6073, ....)
  - *<SDO sub-index>* sub-index (0,1,2, ....)
- call **EC\_SDO\_WRITE**(*<slave address>*, *<SDO index>*, *<SDO sub-index>*, *<SDO size in bits>*, *<new value>*)
  - *<slave address>* drive address (1,2,3, ...)
  - *<SDO index>* object index (0x6073, ....)
  - *<SDO sub-index>* sub-index (0,1,2, ....)
  - *<SDO size>* bit size (8,16,32,64, ....)

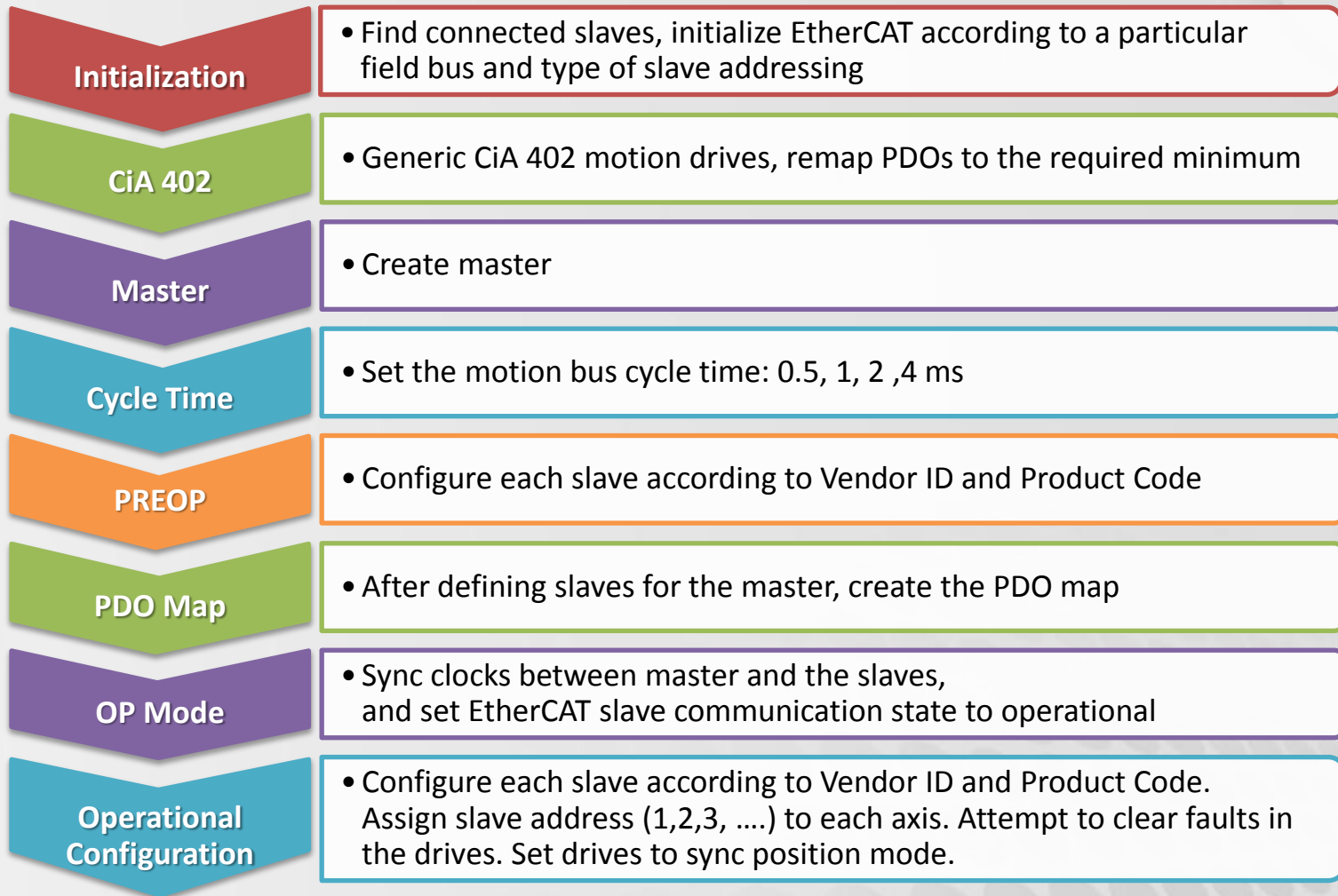
# EtherCAT Bus Cycle Traffic (Simplified)



# Startup

- Libraries (Global)
  - **ETHERCAT.LIB** – main ECAT library, interface between MC-BASIC and C
  - **EC\_USER.LIB** – user specific ECAT interface
  - **EC\_CDHD.LIB** – specific CDHD drive library
  - **EC\_IOMOD.LIB** – specific ECX-DIO8 2.0 IO module
  - **EC\_AI8ME.LIB** – specific AXL\_AI\_8\_ME IO module
  - **CPX\_FB38.LIB** – specific CPX-FB38 IO module
  - **EC\_HCNC.LIB** – specific HCNC HIO-1065 IO module
- Code
  - Some segments in **CONFIG.PRG** – load ETHERCAT.LIB ....
  - **EC\_START.PRG** – loads libraries and starts the EC\_SETUP
  - **EC\_SETUP.PRG** – sets up the EtherCAT
- Complete list at: <http://softmc.servotronix.com/wiki/Category:EtherCAT:Functions>

# EC\_SETUP.PRPG



# IO Setup

- Default CDHD assignment (performed in EC\_SETUP.PRГ)

- 1st Drive

```
sys.din[100] ... sys.din[111]  
sys.dout[100] ... sys.dout[106]
```

- 2nd Drive

```
sys.din[200] ... sys.din[211]  
sys.dout[200] ... sys.dout[206]
```

- 3rd Drive

```
sys.din[300] ... sys.din[311]  
sys.dout[300] ... sys.dout[306]
```

# Troubleshooting

- ?EC\_SLAVES

Address	Mode	Type	Vendor ID	Product Code
0:00	OP	CDHD EtherCAT Drive (CoE)	0x2e1	0x0
1:00	OP	CDHD EtherCAT Drive (CoE)	0x2e1	0x0
2:00	OP	CDHD EtherCAT Drive (CoE)	0x2e1	0x0
3:00	OP	CDHD EtherCAT Drive (CoE)	0x2e1	0x0
4:00	OP	AXL F BK EC Axioline EtherCAT Bus Coupler	0x84	0x290783
5:00	PREOP	CDHD EtherCAT Drive (CoE)	0x2e1	
6:00	OP	CDHD EtherCAT Drive (CoE)	0x2e1	
7:00	OP	CPX-FB38 EtherCAT Bus Node	0x1d	0x26

- ?EC\_MASTER

<b>MAC</b>	<b>0:18:7D:37:07:C3</b>
Status	attached
Slaves	8
Phase Operation	
Link	UP
Tx Frames	5185788
Rx Frames	5155354
Lost Frames	30434
Tx Bytes	1656144179
Tx Errors	0
Tx Frame Rate [1/s]	2000
Tx Rate [Kbytes/s]	1146
Tx Loss Rate [1/s]	0
Frame Loss Rate 0.00 [%]	
Ref Clock 0	



# Servotronix Wiki Articles

- [http://softmc.servotronix.com/wiki/Category:EtherCAT:EC\\_SETUP](http://softmc.servotronix.com/wiki/Category:EtherCAT:EC_SETUP)
- <http://softmc.servotronix.com/wiki/EtherCAT:DIGITAL-IO>
- [http://softmc.servotronix.com/wiki/EtherCAT:CDHD\\_CONFIGURE](http://softmc.servotronix.com/wiki/EtherCAT:CDHD_CONFIGURE)
- [http://softmc.servotronix.com/wiki/EtherCAT:EC\\_INSTALL\\_STX\\_CDHD](http://softmc.servotronix.com/wiki/EtherCAT:EC_INSTALL_STX_CDHD)

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