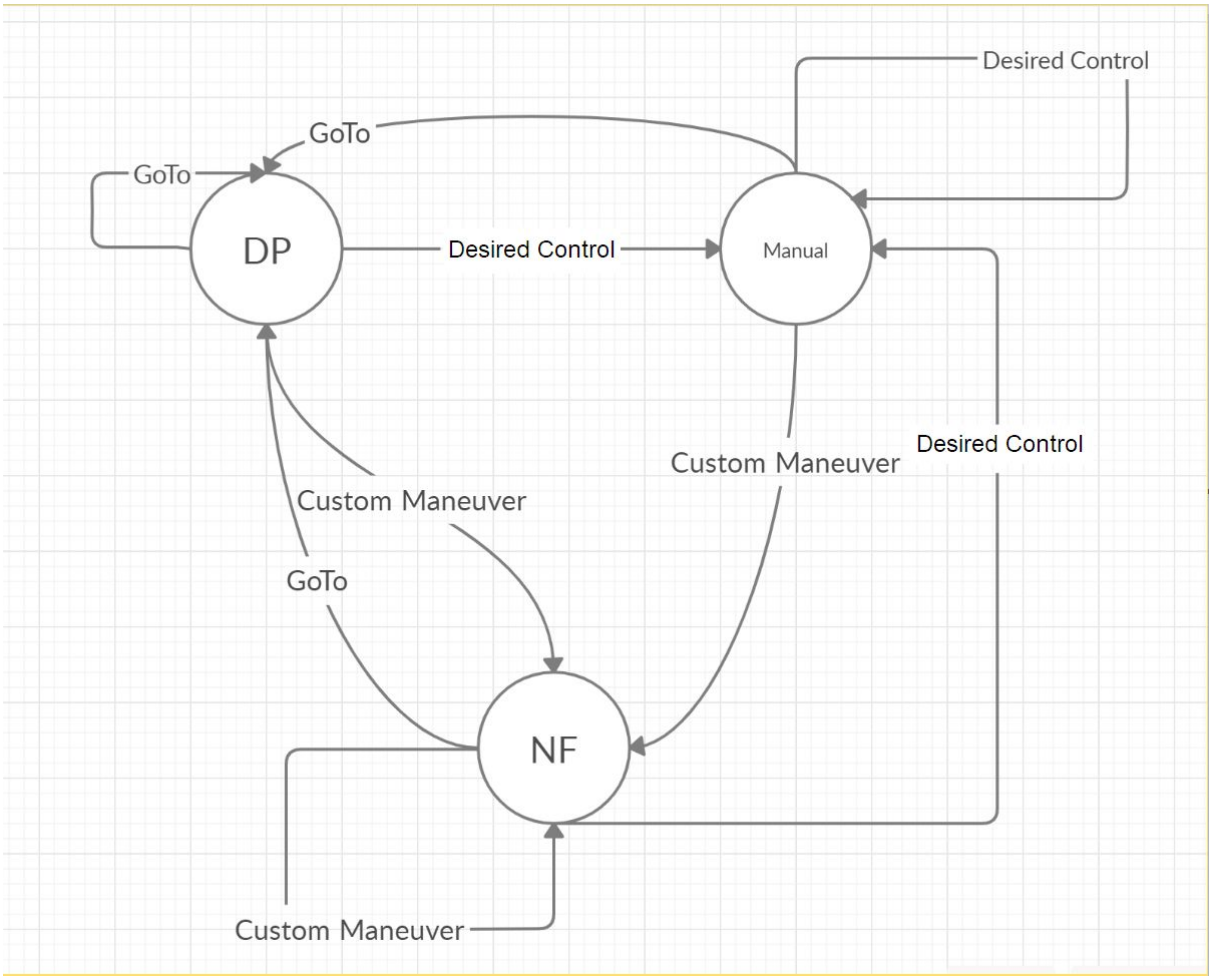
IMC

Proposition of state transition diagram and specification of messages.



All messages are sent as a byte array over TCP, and have a set length which is specified in each message. All messages follow the IMC standard with header and footer, as documented here. This means that the full length of each message is the described length plus 22 (20 header and 2 footer). The messages encapsulated within other messages will only have the message id as header and no footer.

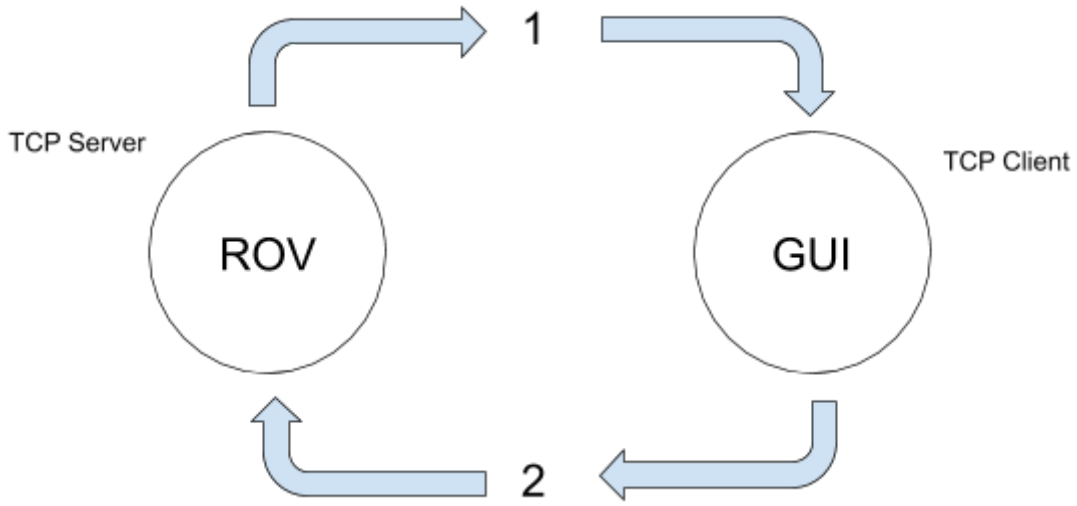
By agreement with SINTEF Ocean the following values are used in the header:

- dst.address : 0x03c0
- dst.entity: 0x07
- src.address: 0x0007
- src.entity: 0x0A

We also allow multiple messages to be concatenated in the same tcp packet. Each IMC package will then include its header and footer.

Order of messages sent

The same pattern used for sending messages in the old system will be implemented, to make sure that the system is easy and quick to implement. The ROV will send a message every 0.2 seconds (this can be changed if needed) and the GUI/control system will answer as soon as the message is received. See figure below:



Messages sent in all states

Messages **from** ROV/Simulator in all states:

The control system wants some of the messages regardless of what state the ROV is currently in. This message will be sent as a prefix in all states. These two messages are placed next to each other and sent in the same TCP package (meaning that the byte array will be 25 + 3 = 28 bytes). For instance, in the state NF, the message “Custom NF State” will be sent in the same package later on.

Custom Estimated State

ID: 1003
Sent continuously (for instance 1 or 10 times each second)
Length: 62 bytes

Name	Abbreviation	Unit	Type	Description	Range
Offset north	x	m	fp32_t	The North offset of the North/East/Down field with respect to some point.	Same as field type
Offset east	y	m	fp32_t	The East offset of the North/East/Down field with respect to some point.	Same as field type
Offset down	z	m	fp32_t	The Down offset of the North/East/Down field with respect to some point.	Same as field type
Rotation over x axis	phi	rad	fp32_t	The phi Euler angle from the vehicle’s attitude.	Same as field type
Rotation over y axis	theta	rad	fp32_t	The theta Euler angle from the vehicle’s attitude.	Same as field type

Rotation over z axis	psi	rad	fp32_t	The psi Euler angle from the vehicle's attitude.	Same as field type
Body-Fixed xx Velocity	u	m/s	fp32_t	Body-fixed frame xx axis velocity component.	Same as field type
Body-Fixed yy Velocity	v	m/s	fp32_t	Body-fixed frame yy axis velocity component.	Same as field type
Body-Fixed zz Velocity	w	m/s	fp32_t	Body-fixed frame zz axis velocity component.	Same as field type
Ground Velocity X (North)	vx	m/s	fp32_t	Ground Velocity xx axis velocity component.	Same as field type
Ground Velocity Y (East)	vy	m/s	fp32_t	Ground Velocity yy axis velocity component.	Same as field type
Ground Velocity Z (Down)	vz	m/s	fp32_t	Ground Velocity zz axis velocity component.	Same as field type
Angular Velocity in x	p	rad/s	fp32_t	The angular velocity over body-fixed xx axis (roll).	Same as field type
Angular Velocity in y	q	rad/s	fp32_t	The angular velocity over body-fixed yy axis (pitch).	Same as field type
Angular Velocity in z	r	rad/s	fp32_t	The angular velocity over body-fixed zz axis (yaw).	Same as field type

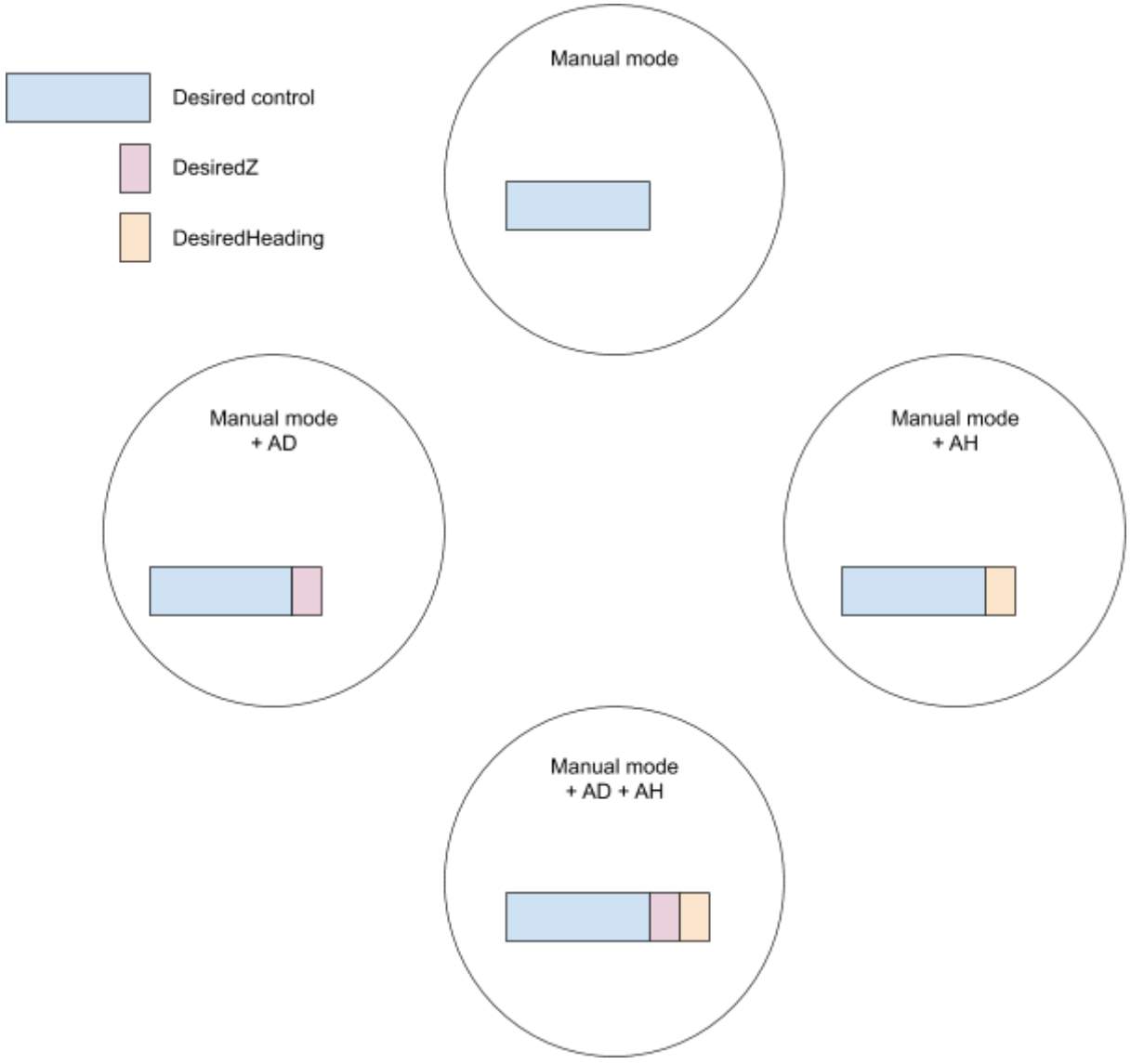
Entity State

ID: 1
Sent continuously (for instance 1 or 10 times each second)
Length: 8 bytes

Name	Abbreviation	Unit	Type	Description	Range
State	state	Enumerated	uint8_t	State of entity 0 - manual mode 1 - DP mode 2 - NF mode	Same as field type
Flags	flags	Bitfield	uint8_t	Flags indicating availability for DP and NF mode Leftmost bit shows availability for activating DP mode. 0 means not available, 1 means available. 0xxxxxx or 1xxxxxxx Second leftmost bit shows availability for activating NF mode. 0 means not available, 1 means available. x0xxxxxx or x1xxxxxx	Same as field type
Complementary description	description	-	uint_32_t (plaintext)	Complementary human-readable description of entity state. Always sends 131072 (dec) - 00000000 00000010 00000000 00000000 (bin)	Same as field type

Manual Mode

Messages **to** ROV/simulator:



The figure above illustrates how the messages Desired control, DesiredZ and DesiredHeading are placed together at the different manual states. DesiredZ and DesiredHeading are combined with Desired control at their state, after the Desired control message. The flag placed at the end of Desired Control indicates whether or not the different forces in the message is active.

Desired control

ID: 407
Purpose: Manual control
Sent continuously (for instance 1 or 10 times each second) when in manual mode
Length: 51 bytes

Name	Abbreviation	Unit	Type	Description	Range
Force along the x axis	x	*N*	fp64_t	Force X along the vehicle's x axis.	Same as field type
Force along the y axis	y	*N*	fp64_t	Force Y along the vehicle's y axis.	Same as field type
Force along the z axis	z	*N*	fp64_t	Force Z along the vehicle's z axis.	Same as field type
Torque about the x axis	k	*Nm*	fp64_t	Torque K about the vehicle's x axis.	Same as field type
Torque about the y axis	m	*Nm*	fp64_t	Torque M about the vehicle's y axis.	Same as field type
Torque about the z axis	n	*Nm*	fp64_t	Torque N about the vehicle's z axis.	Same as field type
Flags	flags	*Bitfield*	uint8_t	Desired Control flags. The left most bit deactivates the first row (force along the x axis) when 1, the	Same as field type

				second bit deactivates the second row etc. Example xx1xxxxx tells that force along the z axis should not be used and xxxxx1xx tells that the torque about the z axis should not be used.	

Desired Heading

ID: 400
Purpose: Auto heading
Important: Must be packaged in a Low Level Control Maneuver message
Length: 10 bytes

Name	Abbreviation	Unit	Type	Description	Range
Value	value	*rad*	fp64_t	The value of the desired heading angle, relative to true north, in radians.	Same as field type

Desired Z

ID: 401
Purpose: Auto depth
Important: Must be packaged in a Low Level Control Maneuver message
Length: 7 bytes

Name	Abbreviation	Unit	Type	Description	Range

Value	value	*m*	fp32_t	The value of the desired z reference in meters.	Same as field type
Z Units	z_units	*Enumerated*	uint8_t	Units of the z reference.	Same as field type

Low Level Control Maneuver

Both Desired Heading and Desired Z messages must be packaged in a Low Level Control Maneuver message.
ID: 455
Length: Depends on the message that is wrapped.

Name	Abbreviation	Unit	Type	Description	Range
Control	control	-	message	Control command: can be of type DesiredZ, DesiredHeading, DesiredRoll, DesiredPitch, DesiredSpeed, DesiredThrottle or DesiredPath.	Same as field type
Duration*	duration	*s*	uint16_t	Duration of the control.	Same as field type

* because the messages are sent continuously this is an excess value. It is important to make sure that the number is greater than the length of the period of sending of messages (for example 0.2 seconds) in our implementation.

DP Mode

Messages **to** ROV/simulator:

CustomManeuver (Custom GoTo / Dynamic Positioning)

ID: 1004
Purpose: Switch to DP mode with given parameters.
Important: Before this is applied, it is checked through Custom Device State with flags message that it is possible to activate DP.
Length: 28 bytes

Name	Abbreviation	Unit	Type	Description	Range
Timeout	timeout	*s*	uint16_t	The amount of time the maneuver is allowed to run.	Same as field type
Maneuver Name	name	-	uint32_t, (plaintext opprinneli g)	Name of maneuver, always “DP”: 148560 (dec) - 00000000 00000010 01000100 01010000 (bin)	Same as field type
North	x	m	fp32_t	The North offset of the North/East/Down field with respect to some point.	Same as field type

East	y	m	fp32_t	The East offset of the North/East/Down field with respect to some point.	Same as field type
Down	z	m	fp32_t	The Down offset of the North/East/Down field with respect to some point.	Same as field type
Yaw	yaw	*rad*	fp64_t	The psi Euler angle in which the vehicle should set its attitude. Use ‘-1’ for this field to be considered. Otherwise the value spans from 0 to 2 Pi.	Same as field type

NF Mode

Messages **to** ROV/simulator:

CustomManeuver (Net Follow)

ID: 465
Purpose: Switch to NF mode with given parameters.
Important: Before this is applied, it is checked through Custom Device State with flags message that it is possible to activate NF.
Length: 33 bytes

Name	Abbreviation	Unit	Type	Description	Range
Timeout	timeout	s	uint16_t	How long the message is active/lasting	Same as field type
Maneuver Name	name	-	uint32_t, (plaintext opprinnelig)	Name of maneuver, always “NF”: 151110 (dec) - 00000000 00000010 01001110 01000110 (bin)	Same as field type
Distance to net	d	[m]	fp64_t	Distance to net	Same as field type
Velocity	v	Negative port, positive starboard [m/s]	fp64_t	Device’s velocity when moving	Same as field type
Z	z	*Samme format som «auto depth»*	fp64_t		Same as field type

Z Units	z_units	z-units, *Samme format som «auto depth»*	uint8_t		Same as field type

Messages **from** ROV/simulator:

Custom NF state

ID: 1002
Purpose: When in NF mode, this message will be sent alongside the custom device state message.
Length: 18 bytes

Name	Abbreviation	Unit	Type	Description	Range
Distance from net	d	*m*	fp32_t	Device's distance from net	Same as field type
Velocity	v	*m*	fp32_t	Device's velocity (along the net). Negative port, positive starboard [m/s]	Same as field type
Degrees	angle	*rad*	fp64_t	Device's degree vs the net	Same as field type