# Example 2

**AUV-borne** position estimation from Doppler, AHRS, inverted USBL, and GPS measurements (2D)

Doppler – velocity measurements

Yaw measurements (AHRS)

USBL – position wrt ship measurements + GPS data

*(comms and relative positioning)*

Filtering Structure

Position and velocity estimates
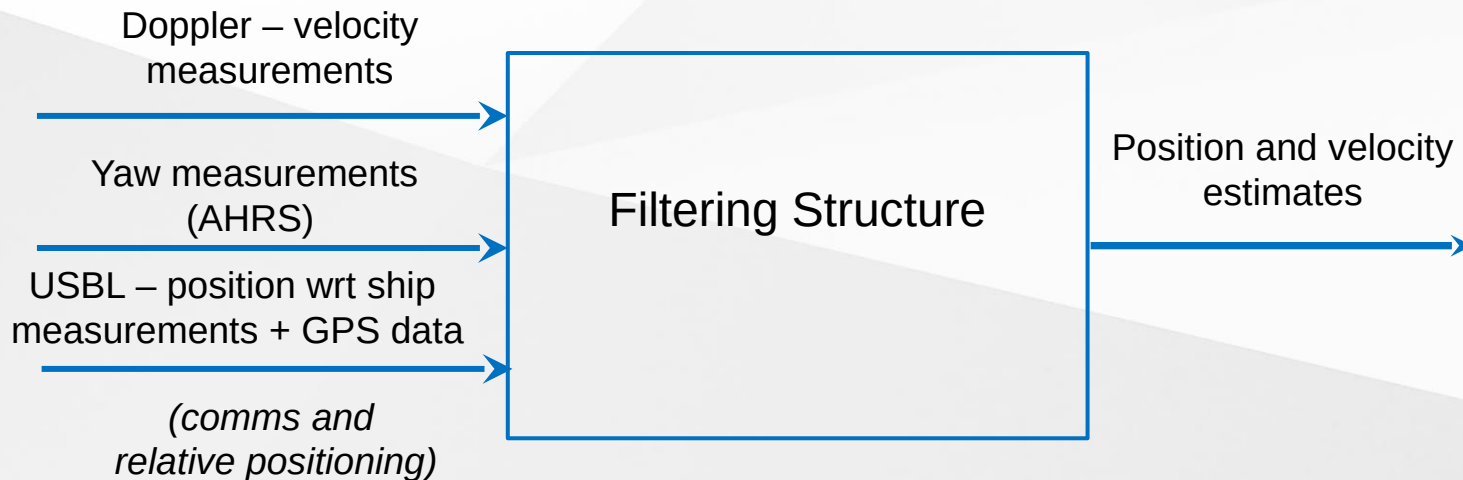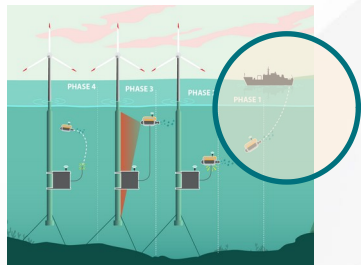
# Example 2



Complementary Filter Structure

$$v_m = v_w = v - v_c$$
$$v = v_w + v_c$$

$$p = (x, y)^T$$
*inertial position*

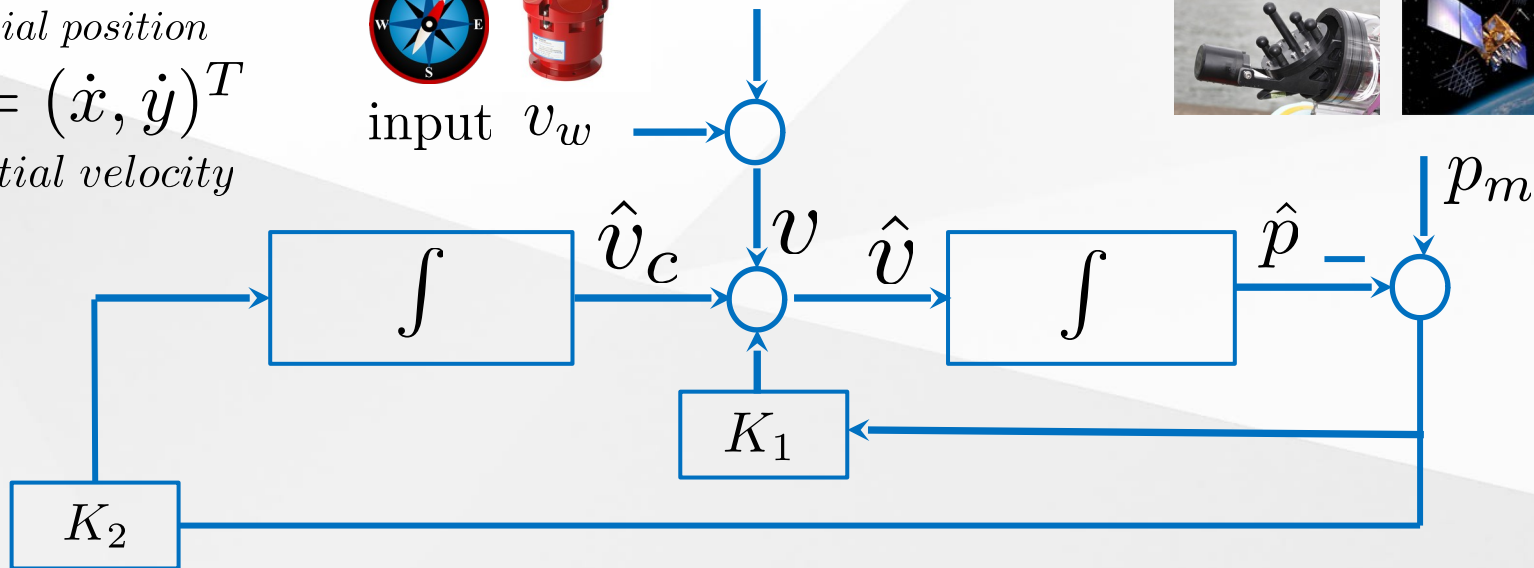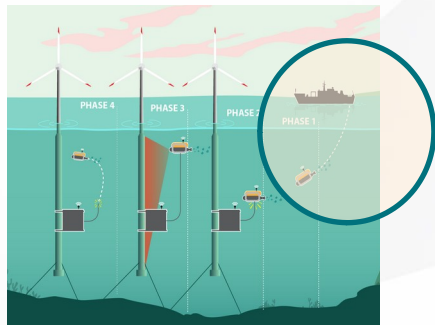$$v = (\dot{x}, \dot{y})^T$$
*inertial velocity*

*current velocity*
$$+v_c$$

input $v_w$

$\hat{v}_c \quad v \quad \hat{v}$

$\int \qquad \int$
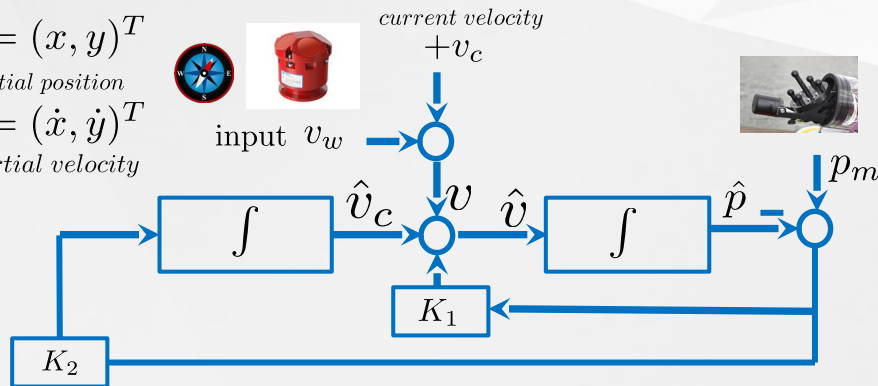
$\hat{p}$

$p_m$

$K_1$

$K_2$

# Example 2

## Complementary Filter Structure

$$\frac{d}{dt}\hat{p} = \hat{v}_c + v_m + K_1(p_m - \hat{p})$$

$$\frac{d}{dt}\hat{v}_c = K_2(p_m - \hat{p})$$

$p = (x, y)^T$
*inertial position*

$v = (\dot{x}, \dot{y})^T$
*inertial velocity*

input $v_w$

*current velocity*
$+v_c$

### Underlying Design Model

$$\frac{d}{dt}p = v_c + v_w + \xi_1 \quad \leftarrow$$
**state noise**

$$\frac{d}{dt}v_c = 0 + \xi_2 \quad \leftarrow$$

$$p_m = p + \eta$$
**measurement noise**