Simple Water Elevation Transit System

Preliminary Requirements Notes #3

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Michael M Lee

Water Elevation Transit System (WETS) Requirements

Overall Plan

- STEP 1: Consider a manual, single lock WETS to clarify:
  - vocabulary, basic operations, operational policies (KISS)

- STEP 2: Consider a manual, multi lock WETS to further clarify:
  - vocabulary, operations, operational policies (KISS)

- STEP 3:
  - Consider multi transit lane WETS and bidirectional transit lanes (KISS).
  - Consider devices to automate a WETS operation (e.g., hydraulic gates, electronic valves, water level meters, etc.) and define logical interfaces (e.g., commands, responses, behavior, etc.) to these devices. This assumes there will be a separate Process I/O domain to handle the actual I/O.

Today

- STEP 4: Produce a final requirements summary for an automated, multi transit lane, multi lock WETS (KISS)

Vocabulary

- A water elevation transit system enables the transit of water vessels through sloped waterways between an upper level of water and a lower level of water. A WETS may have may transit lanes.

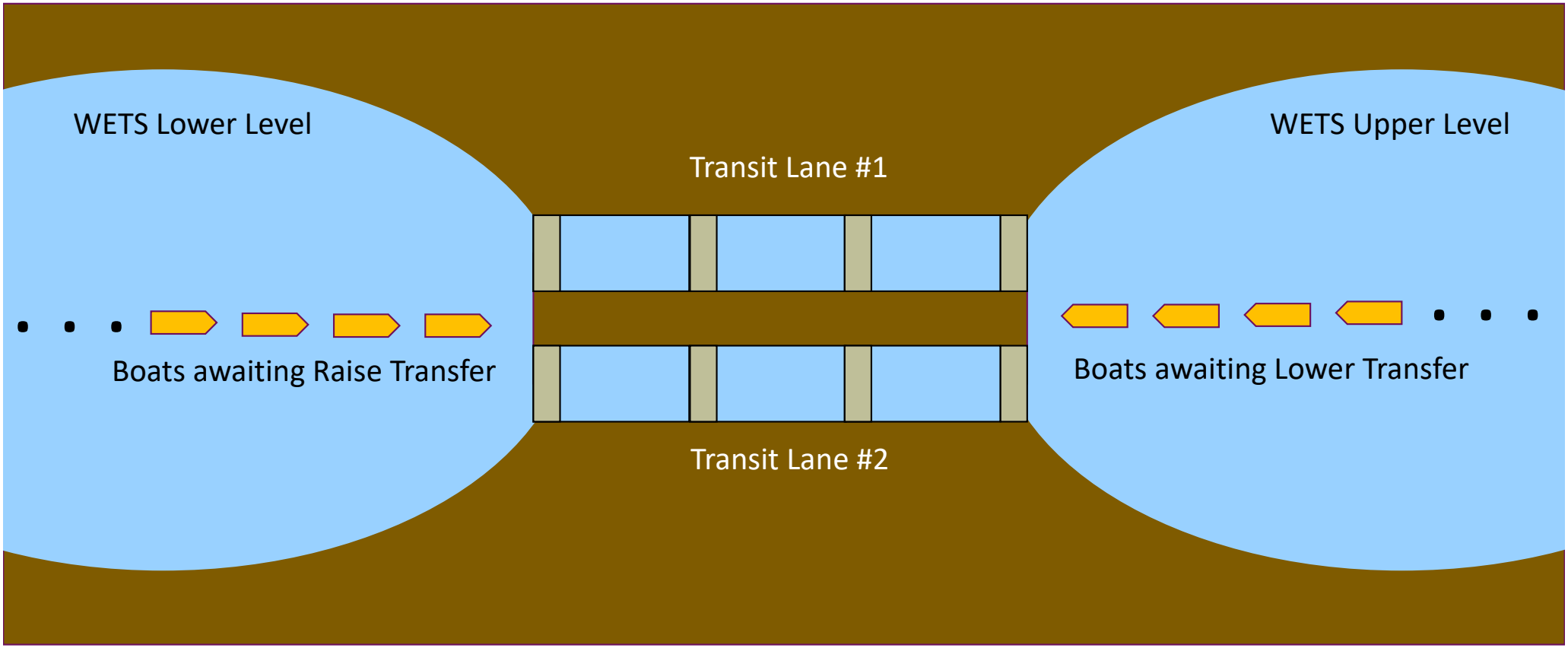
- A transit lane is a distinct path through a WETS. A transit late will have 2 or more gates.

- The movement of a vessel through a transit lane is called a transfer. A transfer to the upper level is called a raise transfer, to the lower level, a lower transfer.

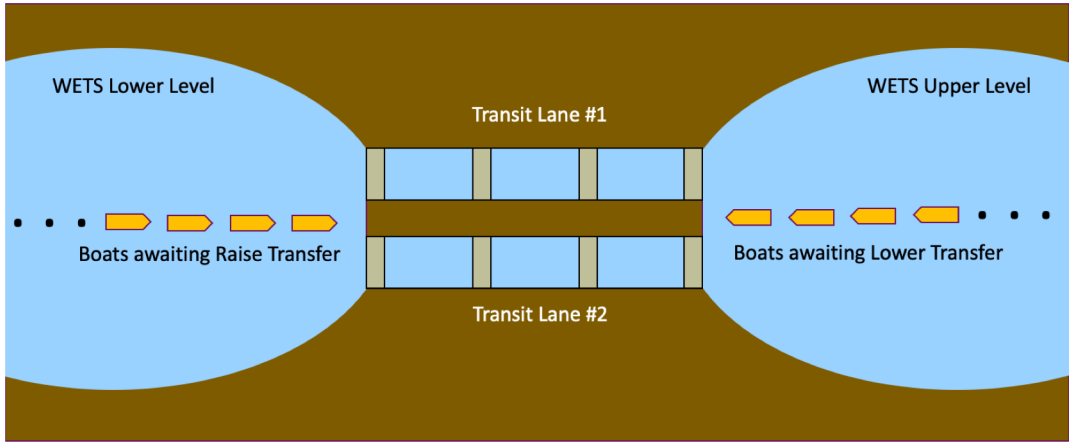
- A gate consists of two doors which can be open or closed to accumulate water or not. Gates contain a culvert allowing water to flow through it. A culvert contains a valve. To control the flow of water through a culvert (open) or not (closed).

- When 2 sequential gates are closed, the water containing volume between them is called a chamber. Controlling the volume of water in a chamber is how vessels are raised and lowered. A chamber is sometimes referred to as a lock.

Multi Transit Lane WETS



Scheduling Transfers in a Multi Transit Lane WETS



KISS Scheduling Assumptions

- A new vessel transfer for a transit lane can be scheduled whenever an active transfer for that lane completes or whenever a new vessel arrives and no transfers are in progress in at least one transit lanes.
- Transit lanes are scheduled sequentially on a “first complete, first schedule” basis.
- Vessels request a transfer when they arrive at their entry side of a transit lane.
- Vessels are scheduled for transfer on a “first come first serve” basis.
- Once a vessel is scheduled, the transfer operation is the same for single and multiple transit lane WETS.

Long Transit Lanes

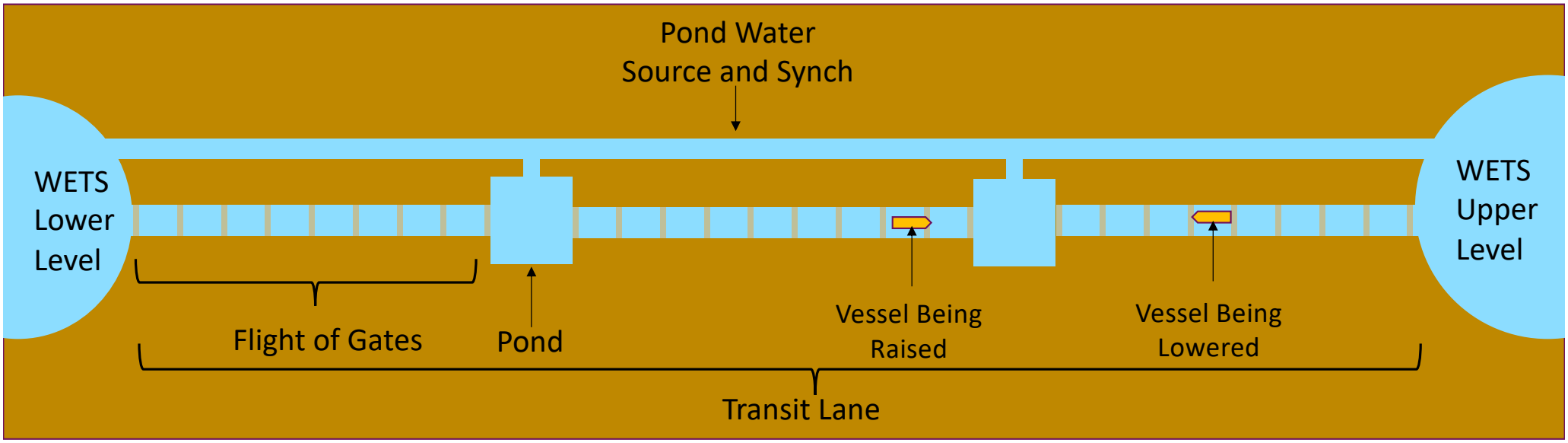
Long transit lanes, with many gates, can take a long time to traverse, making it impractical to only allow a single vessel to traverse it at a time.

To address this, the gates in a long transit lane can be broken into separate flights of sequential gates that are connected by ponds.

Ponds can be thought of as chambers large enough that they can contain multiple vessels. A pond allows vessels that are going in opposite directions to pass each other.

In addition to the water that flows into and out of ponds through the adjacent gates, ponds have a separate source and sink of water as needed. This ensures the ponds can maintain an appropriate water level for operations.

WETS with Flights and Ponds



NOTE:

- Utilizing the pond water source and synch introduces the need for additional water management devices (e.g., valves), their operation and more complex scheduling.
- WETS with multiple flights will be considered outside the scope of Release 1.0 and go into the list of possible enhancements for Releases 1.0+

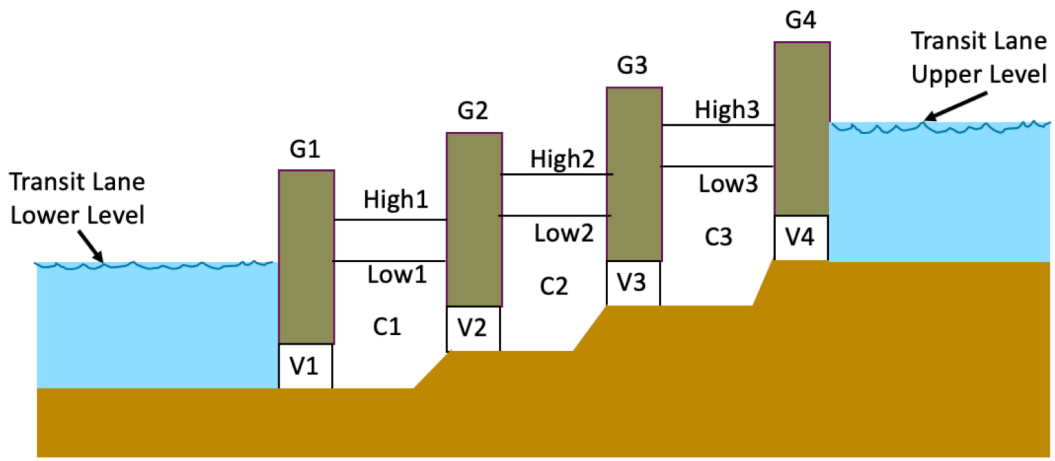
Proposed Automation Capabilities

Gate
- Open and close

Gate Valve
- Open, Close

Tunnel Flow Sensor
- Report when flow rate is zero

Vessel
- Request transfer
- Receive transfer request acknowledgement
- Receive and execute transfer move request
- Report transfer move request complete



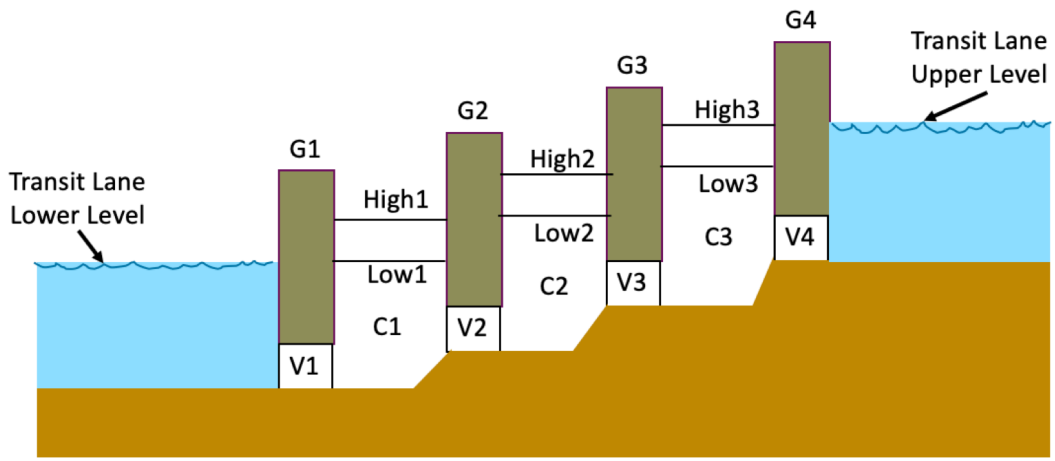
Proposed Automation I/O

Gate
- Output (asynch): Open, Close
- Input (asynch): Open, Close Complete

Valve
- Output (asynch): Open, Close
- Input (asynch): Open, Close Complete

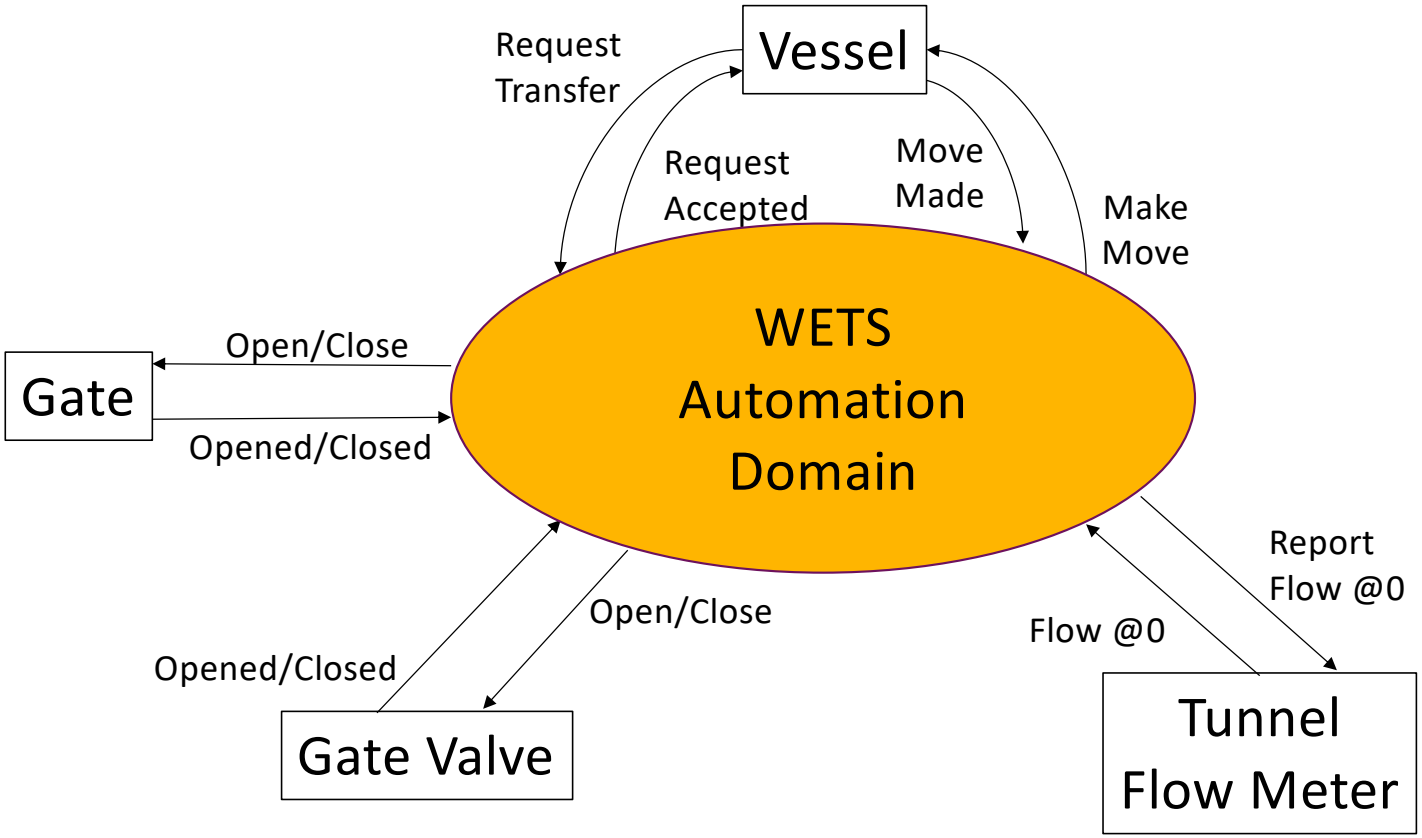
Tunnel Flow Sensor
- Output (asynch) Report when flow rate=0
- Input (asynch): Flow rate at zero

Vessel
- Input (asynch): Request transfer
- Output (asynch): Request acknowledged
- Output (asynch): Make transfer move
- Input (asynch): Transfer move completed

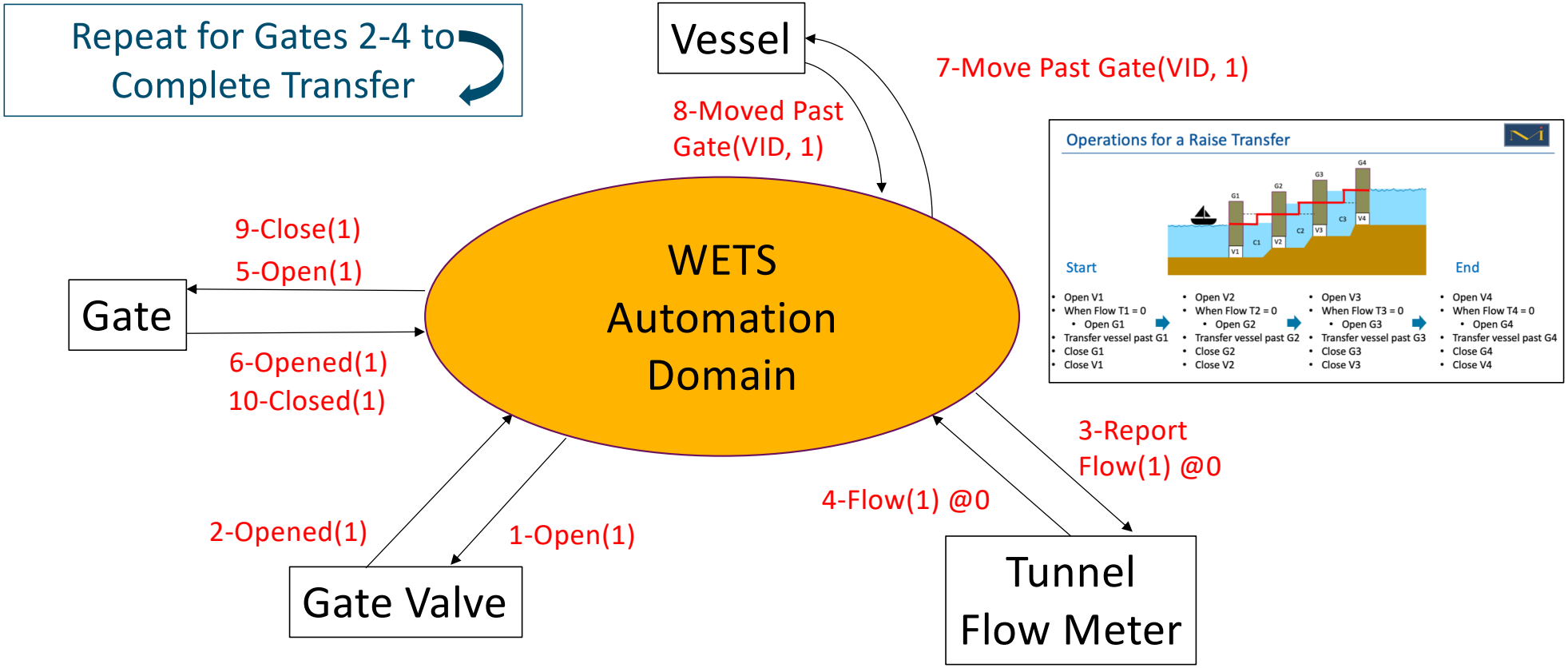


NOTE: We're assuming other domains (e.g., PIO) exist to provide this I/O in the desired format.

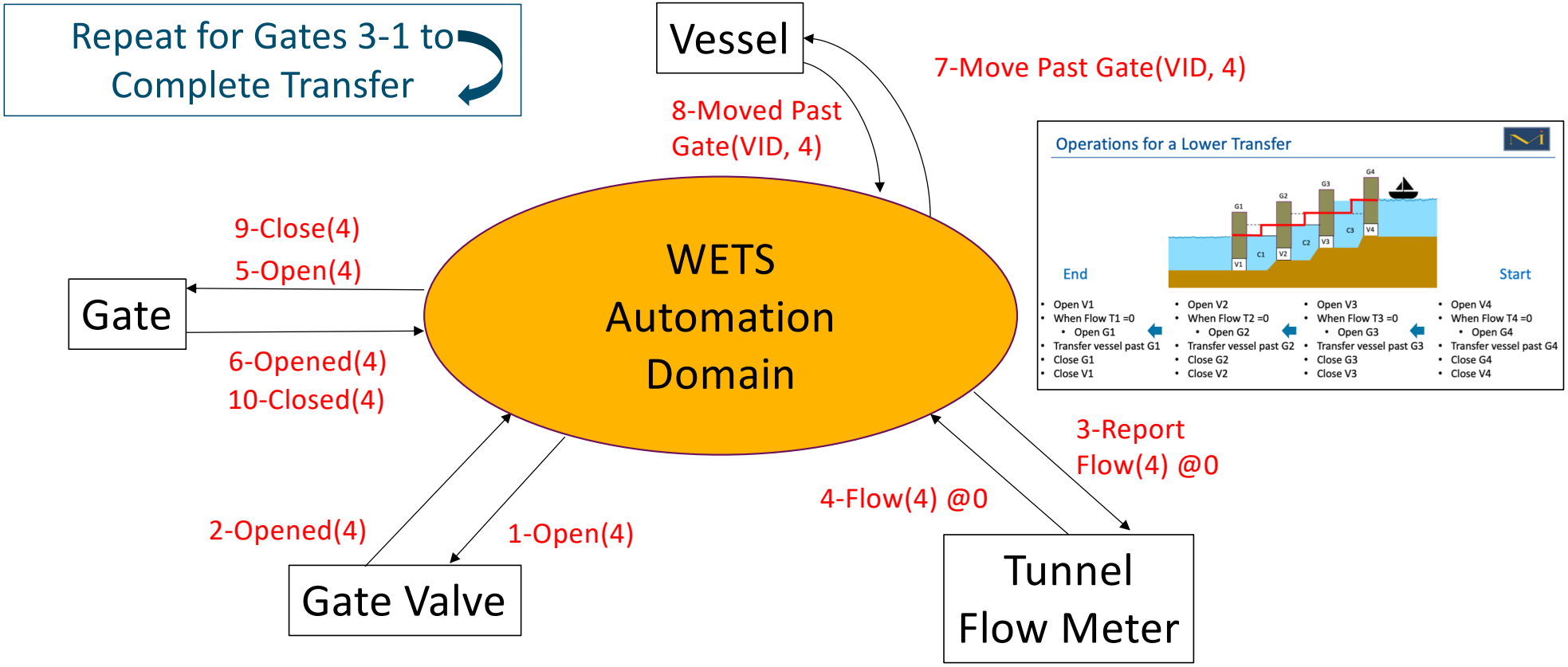
Automation Domain and External Entities



Communications to Start a Raise Transfer



Communications to Start a Lower Transfer



Final Step: Produce Requirements from Tech Notes

Possible Requirements Sources:

- Reactive System Requirements
  - Look at unsolicited system I/O and initial system states
  - Identify final system states
  - Example ➔ Vessel requests transfer, Transit Lane available ➔ Final system state?
- Operational/Safety Requirements
  - Look at things that shouldn't, or have to, happen
  - Example ➔ Before Gate N opens
    - Flow N=0, Valve N=0pen, Gates N-1 and N+1 closed
- Simplifying Assumptions
  - Look at all the KISS assumptions
  - Example ➔ V1.0 will only have a single flight of gates
- Other Sources???

Questions? Comments?? Suggestions???