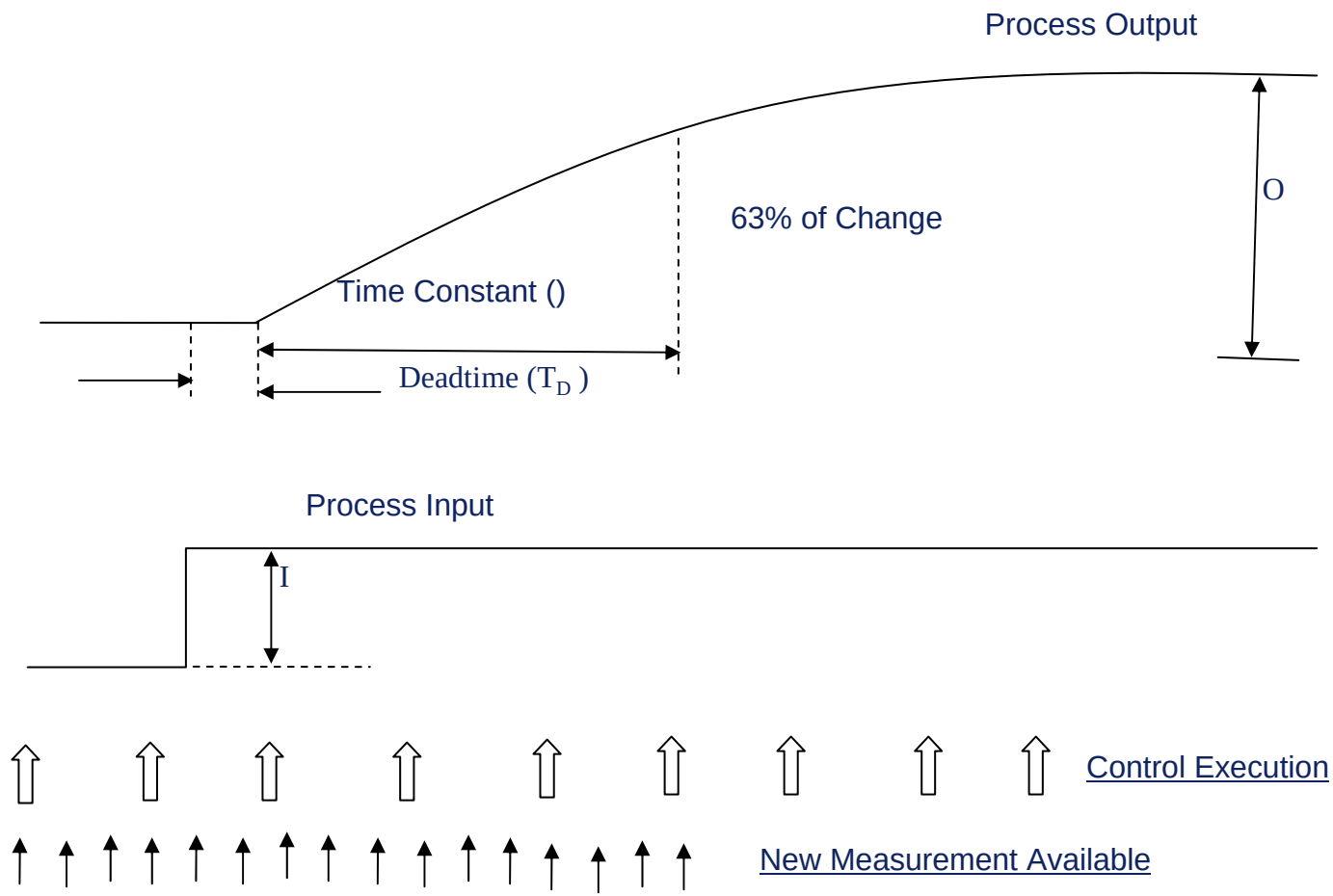
Control and Communications Using Wireless Transmitters

Using Wireless Measurements In Control

- To reduce transmitter power consumption, it is desirable to minimize how often a measurement value is communicated.
- To avoid the restrictions of synchronizing the measurement value with the control, most multi-loop controller are designed to over-sample the measurement by a factor of 2-10X.
- Also, to minimize control variation, the typical rule of thumb is that feedback control should be executed 4X to 10X times faster that the process response time, process time constant plus process delay. Thus, to satisfy these requirements, the measurement value is often sampled much faster that the process responds

Traditional Approach – Oversampling of Measurements Used in Control



Reducing Measurement Sample Rate

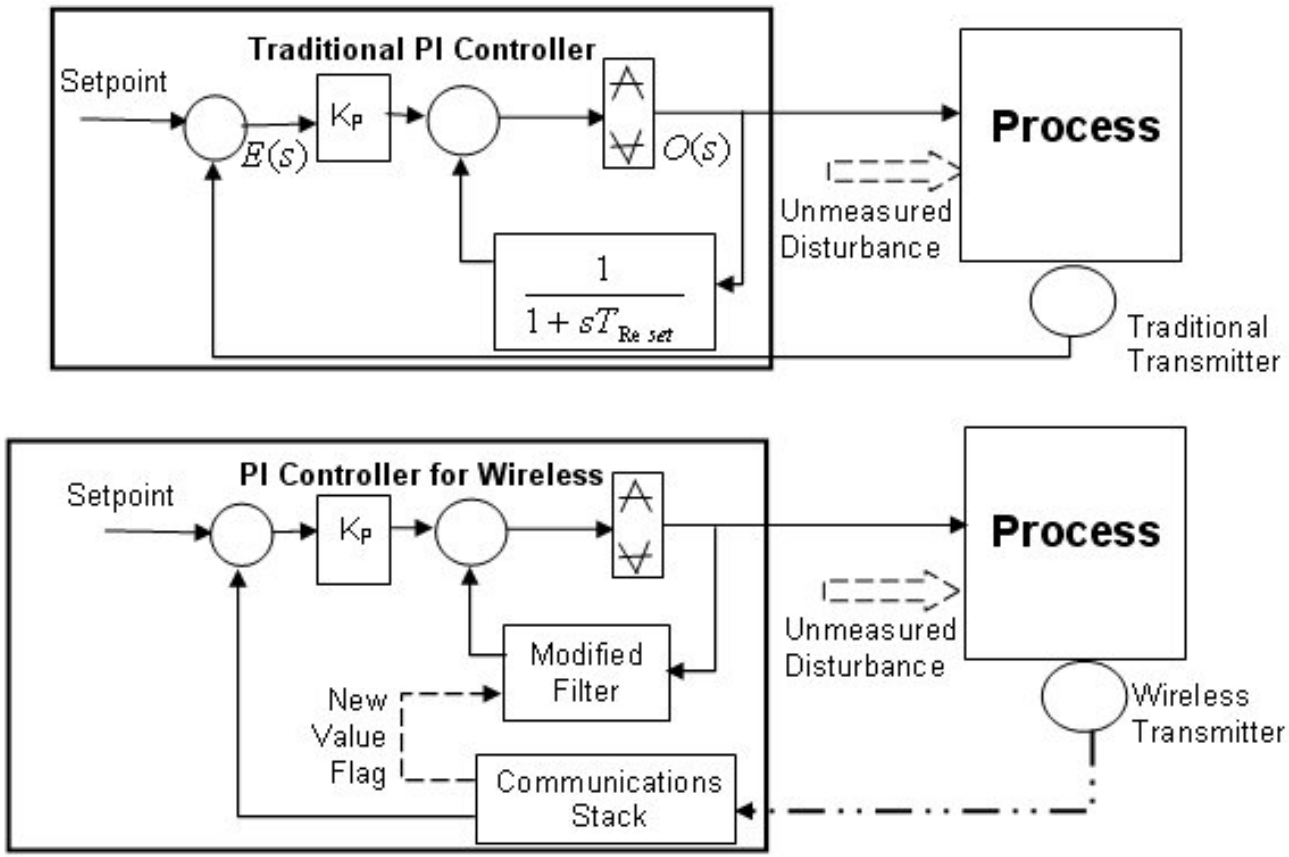
- By synchronizing measure and control execution, as done in fieldbus devices based on Foundation Fieldbus, then it is possible to eliminate the need to over sample the measurement.
- However, if the traditional approach is taken in scheduling control 4-10X faster than the process response, then the power consumption associated with the transmission of the measurement value may be excessive for all but the slowest types of process.
- Slowing down the control execution to reduce the power consumption associated with communication may increase control variability when the process is characterized by frequent unmeasured disturbances.

New Approach to Reduce Measurement Update

- Power consumption can be minimize by designing transmitters and wireless communication according to the following rules:

  - The transmitter will periodically sample the measurement 4-10x faster than the process response time.
  - If the magnitude of the difference between the new measurement value and the last communicated measurement value is greater that a specified resolution or if the time since the last communication exceeds a refresh time then the new value will be communicated.

Restructuring PID for Wireless Measurement



- To effectively use the proposed communication rules, then PID control based on external reset may be restructured to reflect the reset contribute for the expected process response since the last measurement update

External Feedback Component

- To account for the process response, the filter output may be calculated in the following manner when a new measurement is received.

$$F_N = F_{N-1} + \left(O_{N-1} - F_{N-1}\right) * \left(1 - e^{\frac{-\Delta T}{T_{Reset}}}\right)$$

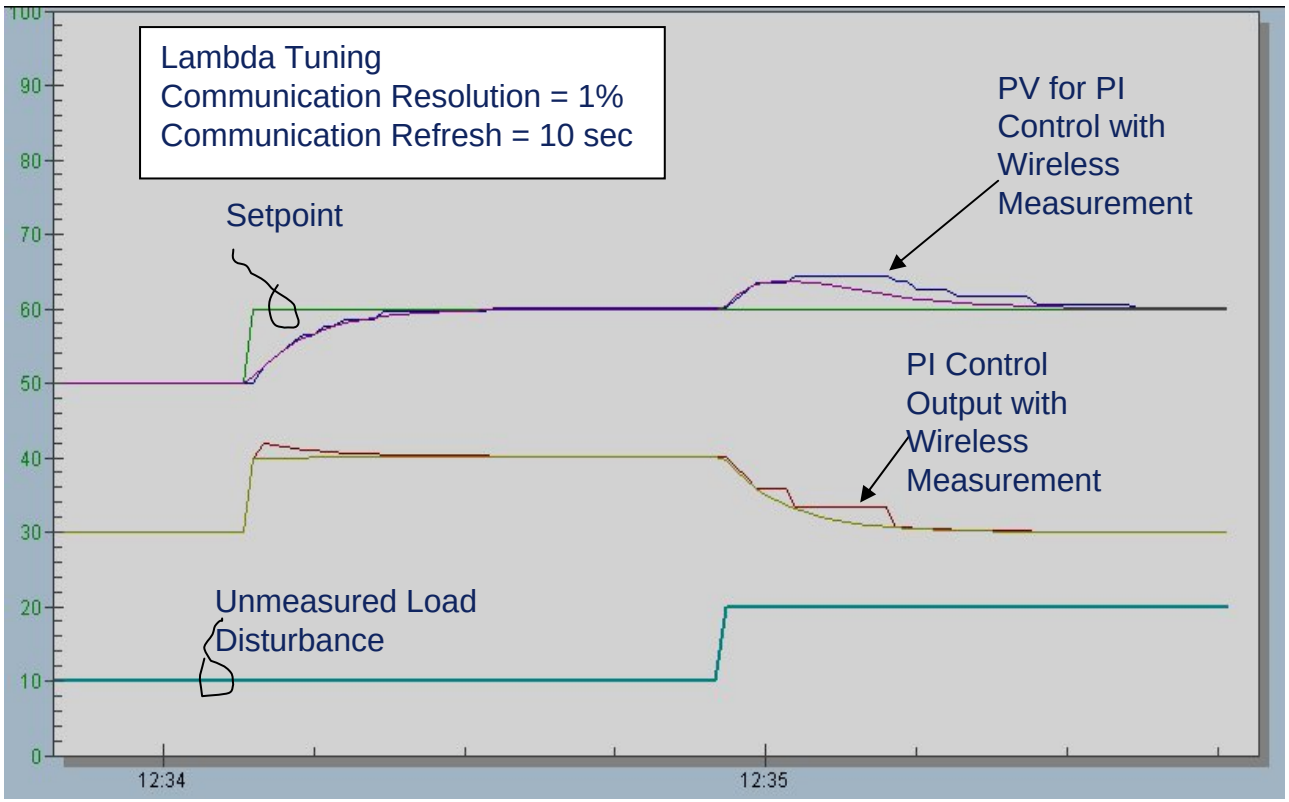
where $F_N = New\ filter\ output$

$F_{N-1} = Filter\ output\ last\ execution = filter\ output\ after\ last\ new\ measurement$

$O_{N-1} = Controller\ output\ last\ execution$

$\Delta T = Elapsed\ time\ since\ a\ new\ value\ was\ communicated$

PI Response for Setpoint and Load Disturbances



- The wireless transmitter follows the Rules for Transmitting a New Measurement Value.
- The measurement value is for standard PI is communicated as frequently as the PI control algorithm executes.

Control Performance and Communication Requirement

- The number of communications during the duration of the test was reduced by over 96 % with minimal impact on control performance.

Communication and Control Setup	**Number of Communications**	**IAE**
Periodic /standard PI controller	692	123
Communication Rules/ PI controller for Wireless	25	159

Summary

- The power that must be supplied by a transmitter for data transmission can be significantly reduced when the proposed communication rules and the PID controller modifications are used with wireless transmitters.
- This reduction in power requirement increases the number of control applications that may be addressed using wireless transmitters.