SPARTAN CONTROLS

Experience Industrial Innovation

Canfor Bleaching Advanced Process Control

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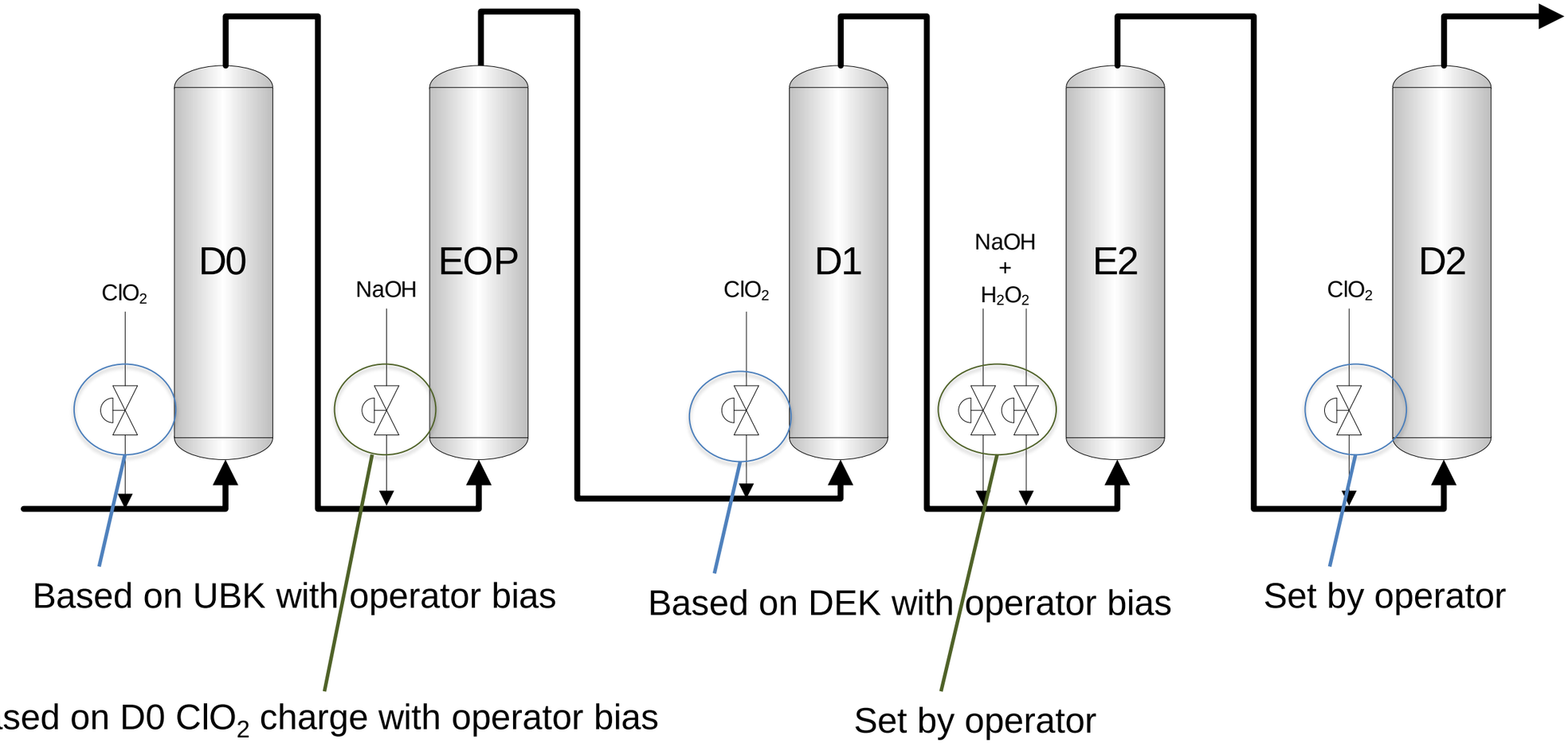
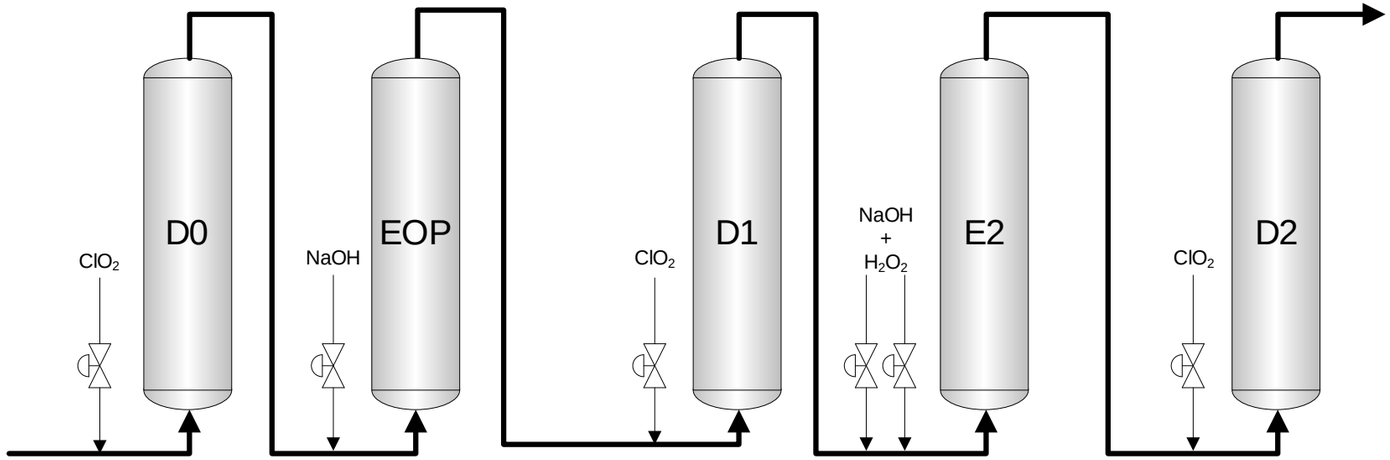
Agenda

- Background
- Regulatory Control Cleanup
- Measurements and Analyzers
- Advanced Process Control Strategy
- Results & Discussion

Background – Original Bleach Plant Control



Background – Original Bleach Plant Control



Comments

- Generally worked well
- Didn’t use all available measurements, but unclear on how to incorporate them into the existing strategy
- Suspected potential cost savings

Background – Project Objectives

Develop a modern bleach plant control strategy that leverages all available (and useful) measurements

- Reduce bleaching costs by about $1.5 million annually
- Easy to maintain
- Better operator graphics, information, and flexibility

Regulatory Cleanup

You don’t have to control issues if you fix them at the source!

- Eliminate or reduce upstream disturbances
- Rework E1 A mill temperature controls to replace MP steam with LP steam
- Added level control to A mill D0 stage
  - Operators doing good job but why add extra work?
- pH control improvements and review
  - Recommending adding vat pH to all E stages

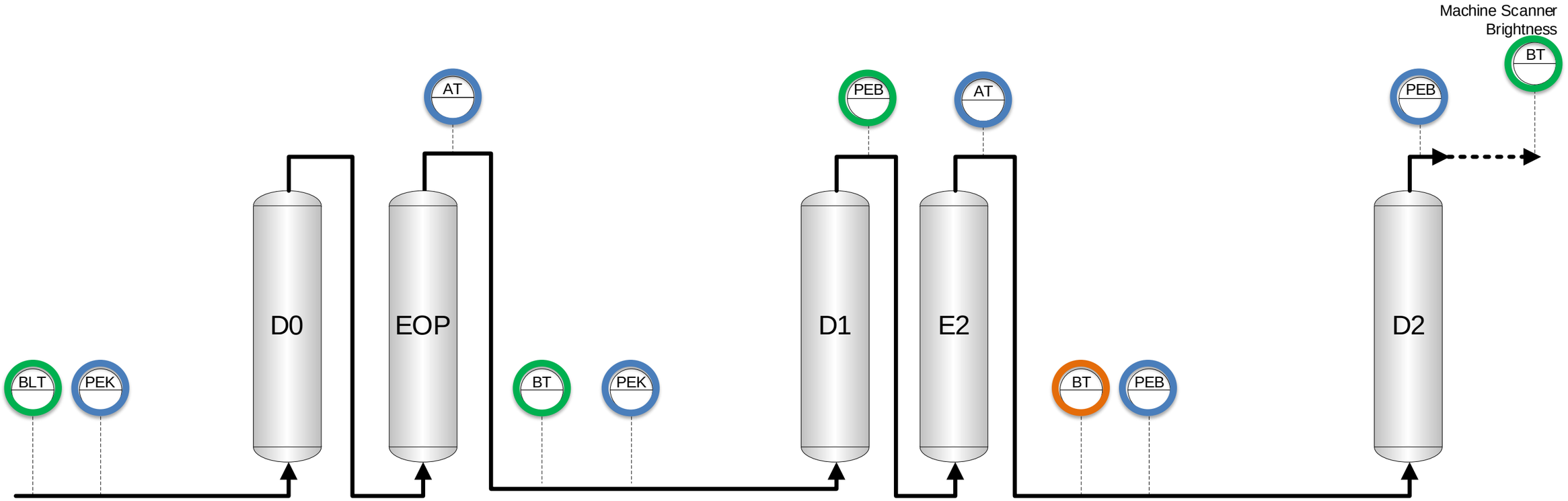
Measurements & Analyzers

Replaced Aging Measurement

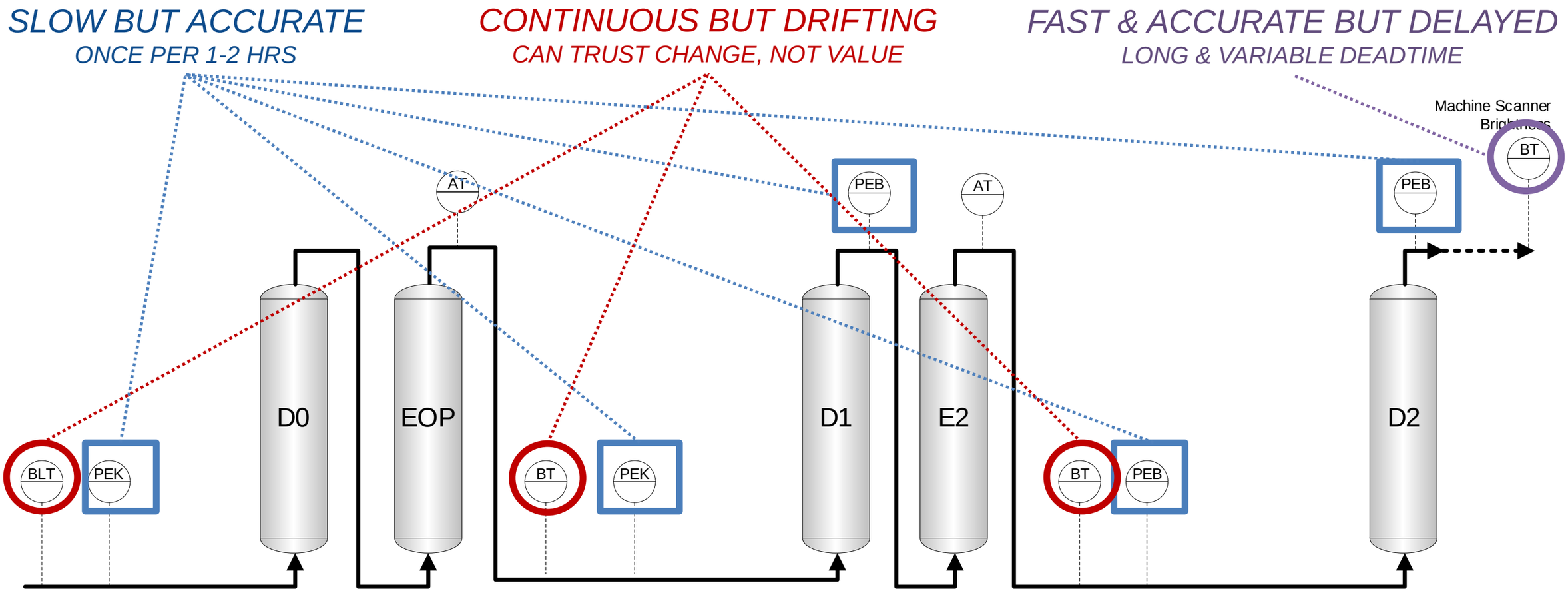
Unused (directly by control) Available Measurements

Moved Measurements

AT – pH
BLT – Bleached Load
BT – Brightness
PEK – Pulp Eye (Kappa)
PEB – Pulp Eye (Brightness)



Measurements & Analyzers – Making Use of Available Signals



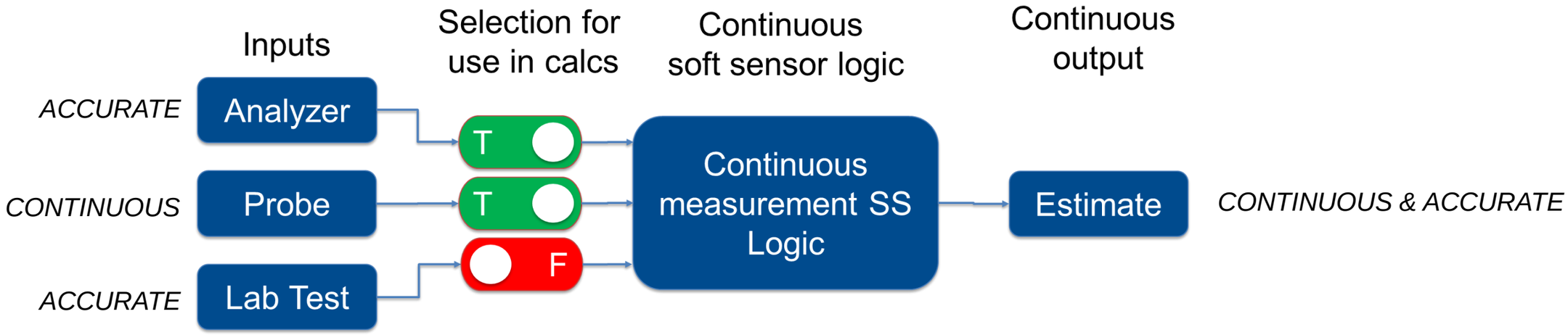
Measurements & Analyzers – Accurate, Continuous Estimates

1. Use the latest analyzer or lab test

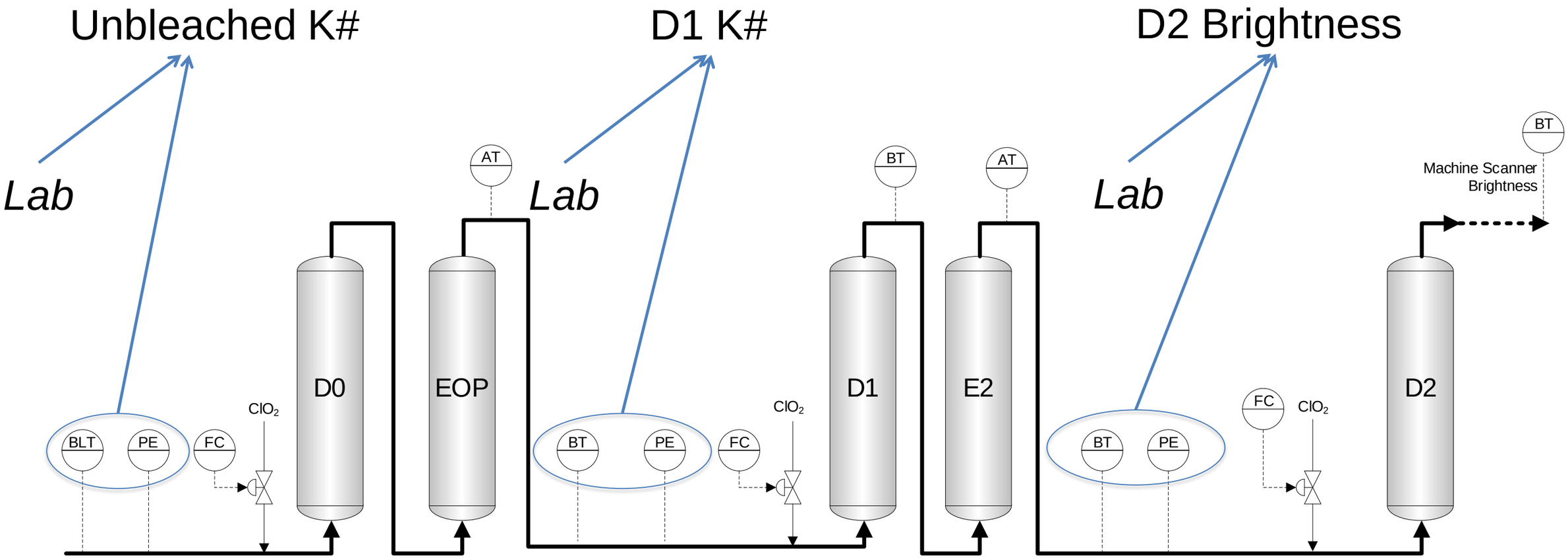
2. Use available continuous measurements to extrapolate between tests

3. Program flexibility to choose valid measurements:

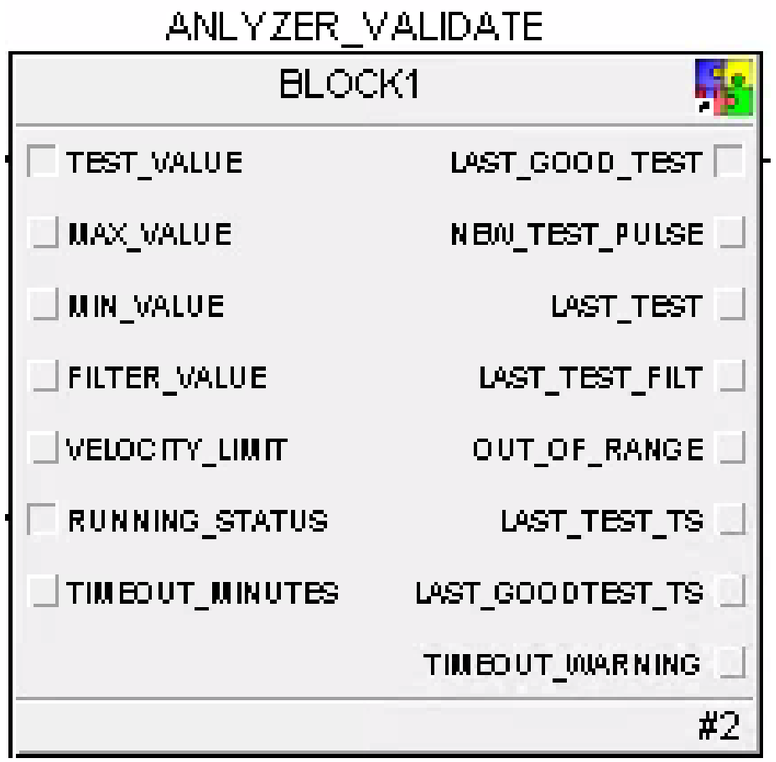
- Probe
- Analyzer
- Lab test
- or any combination of these



Measurements & Analyzers – Accurate, Continuous Estimates

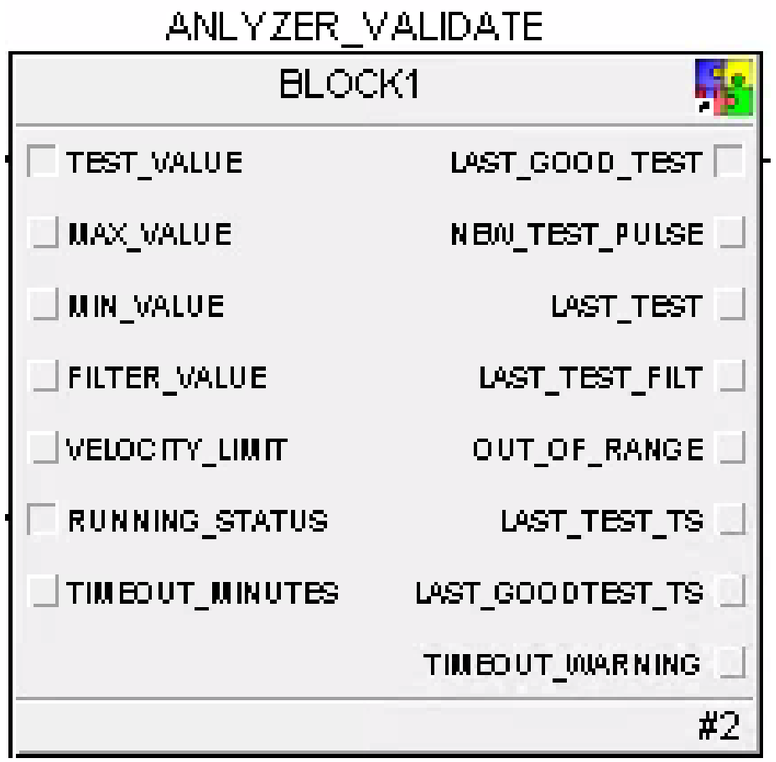


Measurements & Analyzers – Programming for Robustness



- All analyzer and probe signals are “wrapped”
- Analyzer checks:
  - In range, time since last test, process running etc.
  - Produces “Last good value” with timestamp and current status (ok or not)
  - Other data available (last value, time since last test, etc.)
- Probe checks:
  - Similar except for timestamps
- Wrappers make the controls much more robust and easy to follow
  - Feedforward uses last good value
  - Feedback automatically disabled when good value not available

Measurements & Analyzers – Programming for Robustness



Implemented as class object in DeltaV

- Ensures consistency, accuracy, and easy maintenance
- Programming consistency keeps graphics consistent and easy to configure
- Additions and bug fixes are updated for all instances automatically
- Easy to copy and paste - 10 analyzer values in bleach plant alone

  Can be used for any analyzer value (e.g. decker K#)

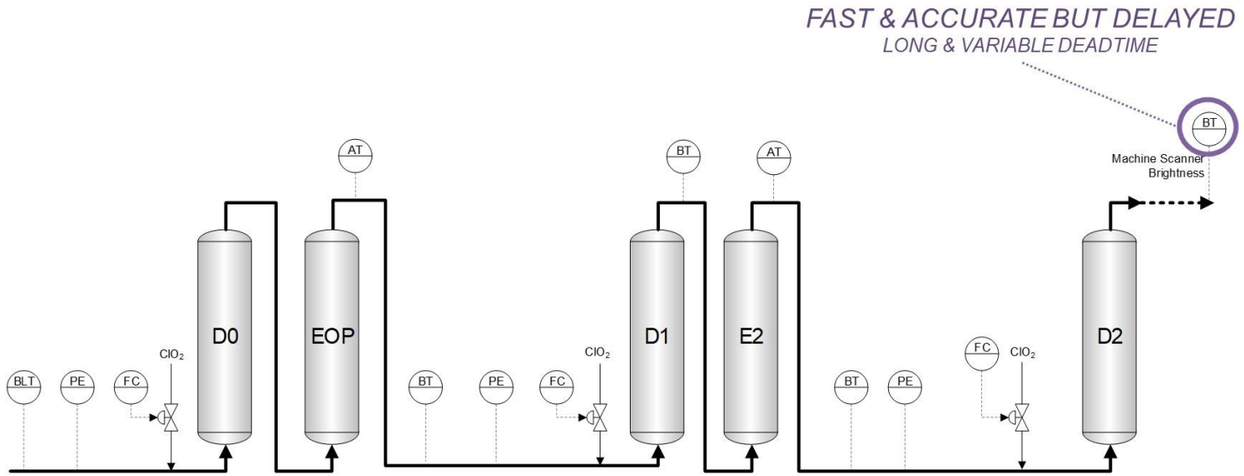
Measurements & Analyzers – Machine Scanner Brightness

Why we want to use it

- Highly accurate and reliable
- High frequency (every scan)
- **Sales is based on this signal**

Why it's difficult to use

- Deadtime is long and depends on bleached Hi-D levels and production rate
- Stock crossover between mills
- Possible broke addition
- Machine may not be running



Measurements & Analyzers – Machine Scanner Brightness

How can we use it *effectively*?

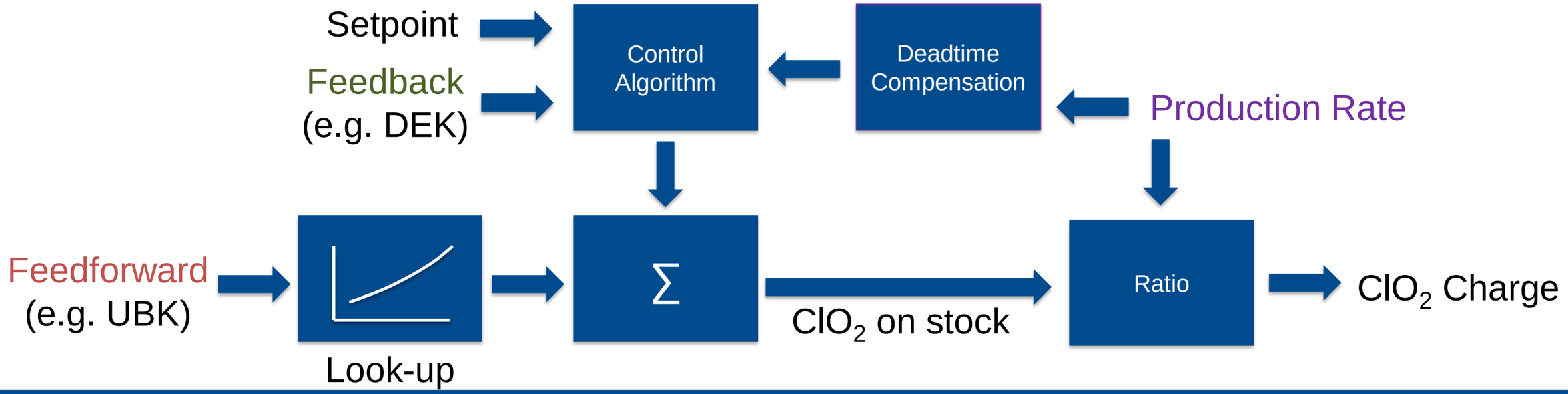
- Not possible to incorporate high frequency changes
  - Too much deadtime between bleach plant and scanner
- Worth doing if final brightness is commonly on same side of setpoint (e.g. high or low) for long periods of time compared to the deadtime (9+ hours)
  - Historical data analysis indicated that long term brightness averaged about 0.40 points above desired setpoint, therefore it is worth worth doing

Where can we use it *effectively*?

- System adjusts both D2 charge and D1 charge
  - Not enough range on D2 charge for full correction

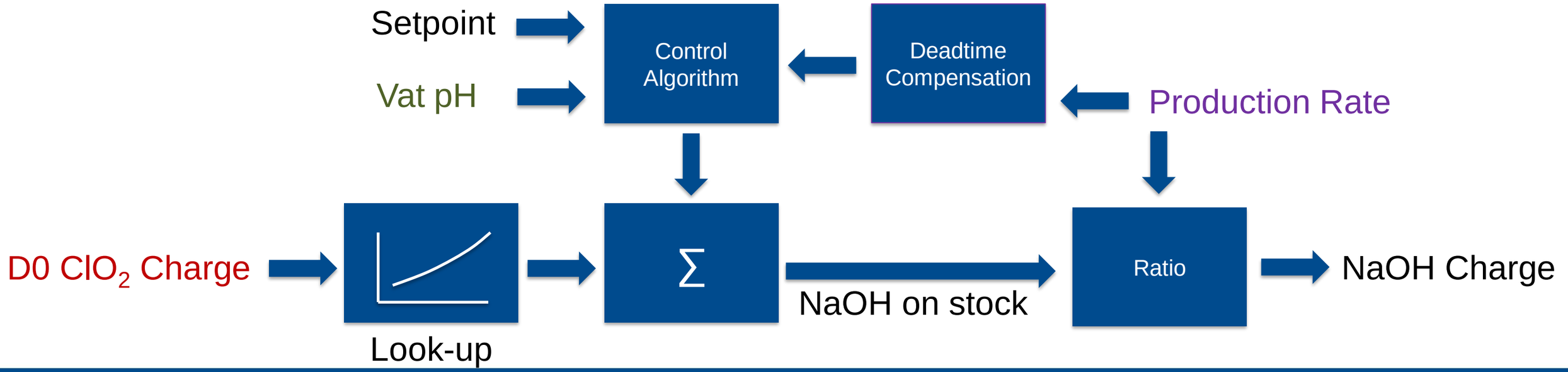
Process Control - Tower Control Strategy Overview

- Control strategy uses model reference control
  - **Feedforward:** Proactively adjust based on upstream changes
  - **Feedback:** Respond to setpoint error of controlled measurement
  - **Deadtime compensation:** Make a change then wait for a response; don't over-react



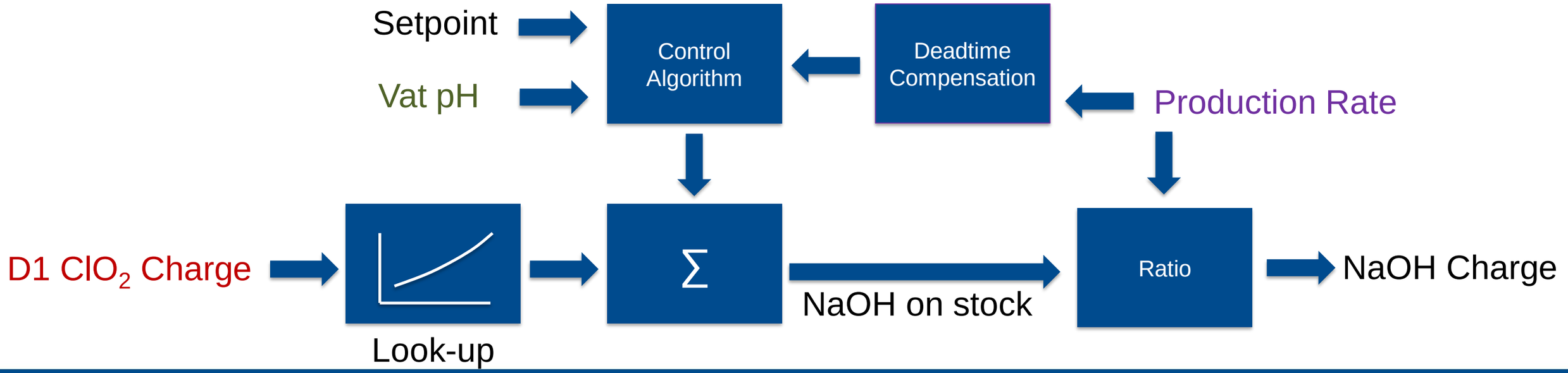
E stage pH Control

- Tried several variations of control
- Final strategy:
  - Tracked D0 ClO_2 as feedforward
  - Vat pH + lab correction as feedback



E2 Stage pH control

- Use same strategies as for E1 control
  - Tracked D1 ClO_2 as feedforward
  - Vat pH + lab correction as feedback



E2 Peroxide Control

- Concept devised by Canfor
- Usually runs to a fixed value
- Variable boost during upsets
  - High DEK (tracked) or
  - Low D2 inlet brightness
- Allowed the average to be lowered while helping reduce upsets

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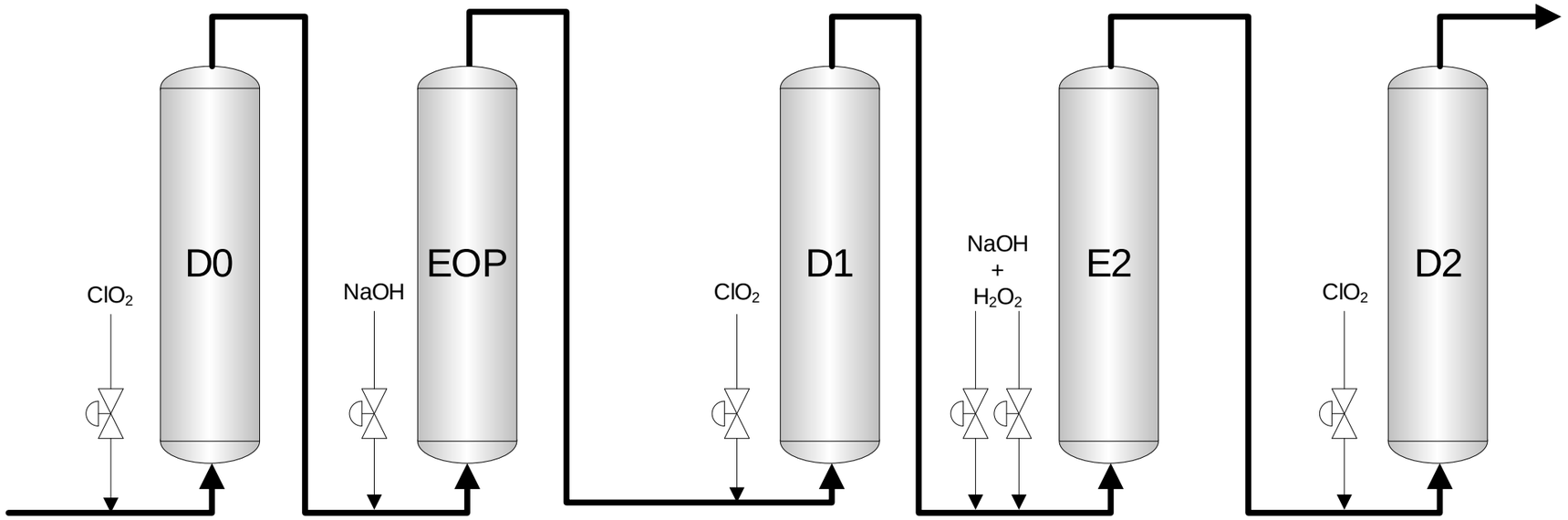

Results

- **Total net savings: $2.5 million per year**
  - ***$9.93/T in A Mill; $8.25/T in B Mill***
  - *Flexible design facilitated post-commissioning optimization and refinement by Canfor, which accounted for 40% of savings*
  - ~50% of savings from rebalancing and controlling D0-D1 ClO_2
  - ~33% of savings from E1 and E2 H_2O_2 and E2 NaOH

- Low brightness pulp reduced by 73% in A mill and 36% in B mill
  - Not included in savings