Fieldbus Foundation™
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# FOUNDATION™ Fieldbus
# Better PID Control with FF than 4-20mA

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# Agenda

1. Control in FOUNDATION fieldbus versus Control with 4-20 mA.
2. Video Link from the Control Engineering - Understanding the user case for Control in Field.
    - Summary of the user case for CIF.
    - Test Results of 250ms scan time versus fast process, 10s, and 50s process scan time.
    - Disturbance Rejection
3. Significance of the Industrial Systems and Control (ISC) study for Control in the Field.

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# Control with Fieldbus versus Control with 4-20 mA

# Control with Fieldbus versus Control with 4-20 mA

1. Foundation Fieldbus technology allows for both.
2. Foundation Fieldbus technology supports control in the field (CIF), which allows a sensor to form its own self-regulating PID loop, independent of the host control system.
3. A new study has been completed by **Industrial Systems and Control (ISC)**, an engineering consulting group in Glasgow Scotland, that examines how CIF operates and where it is likely to offer the greatest advantages over traditional host-based process control.
4. Dr. Andy Clegg  from the Industrial Systems and Control, Ltd in Glasgow explains the parameters of the study and the basic findings.
5. A spin-off company from University of Strathclyde
6. Circumstances under which the high determinism of CIF can out-perform conventional loops driven by a PLC or DCS.

# Video – Understanding user case for CIF

1. This video link shows Dr. Andy Clegg working on a project with the Fieldbus Foundation.

   http://www.controleng.com/media-library/videos/videos/video-understanding-the-user-case-for-cif.html

# Summary

1. For fast loops, the performance of control in the field is significant better than 4-20mA.
2. Benefits of the very highly deterministic nature of control in the field really come into its own on fast process control loops, typically the **pressure and flow** loops, the case study shows the performance of these loops improved by about 10-15% over a 4-20mA loop.
3. For slow process control loops, typically the **temperature and level** (50secs or a minute settling time) the performance benefit is lesser.

# Test Results (250ms process time)

1. No performance difference between fieldbus and 4-20mA loops for the P and PD controllers.
2. However, for PI and PID fieldbus control (CIF) performance is better than 4-20mA:
   - **14.8% better for regular stepping disturbance**
   - **29.3% better for stochastic (random values over time) disturbance.**
   - **If the disturbance is varying slowly the improvements is less significant.**

# Test Results (10s process time)

1. Negligible performance difference between fieldbus and 4-20mA loops for P and PD controllers – for slow disturbances.
2. Fieldbus improvement for PI and PID:
   - **Most beneficial at slow controller cycle-time; significant if controller is run slow to decrease load; more loops per controller.**

| Controller Scan Time | Step Disturbance (Improvement) | Stochastic Disturbance (Improvement) |
|---|---|---|
| 250 ms | 6% | 5.5% |
| 500 ms | 1% | 8.5% |
| 1000 ms | 8% | 15% |

# Test Results (50s process time)

1. Fieldbus improvements for PI and PID controllers:
   - **Most beneficial at slow controller cycle-time; significant if controller is run slow to decrease load; more loops per controller.**

| Controller Scan Time | Step Disturbance (Improvement) | Stochastic Disturbance (Improvement) |
|---|---|---|
| 250 ms | 1.5% | 1.5% |
| 500 ms | 2.4% | 2.5% |
| 1000 ms | 4.4% | 4.8% |

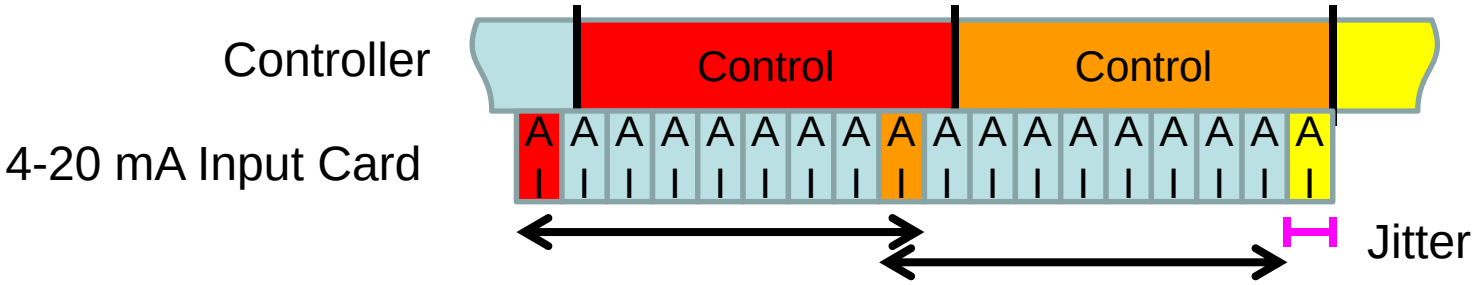
# Disturbance Rejection

1. Loops affected by fast disturbances (e.g. step changes or random effects) will have the most benefits for Control in the Field.
2. Slowly varying disturbance like temperature and level sees no performance benefits.
3. There are a lot more benefits to using control in the field than just the determinism:
    - **This study is looking at the control loop performance, i.e. how much the process variability can be reduced by fieldbus technology.**

# Significance of the Industry System and Control (ISC) User Case for CIF

# Fieldbus Control is better than Analog

1. CIF is “jitter” free (no undesired deviation), i.e. constant sampling time.
   - Fieldbus devices are time synchronized.
   - Fieldbus communication and control is scheduled.
   - A 250ms marcocycle is a 250ms every-time.
2. 4-20mA control loops is not “jitter” free.
   - AI and AO cards are not time synchronized with the Controller.
   - A 4-20mA loops has the following:
     1. varying sampling time (not ideal for PID).
     2. longer total loop latency (input to output).

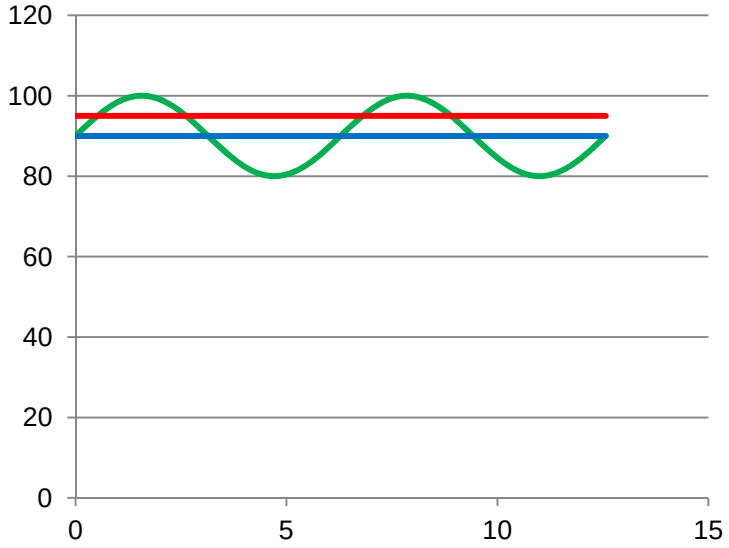


# Why is High Process Variability Bad?

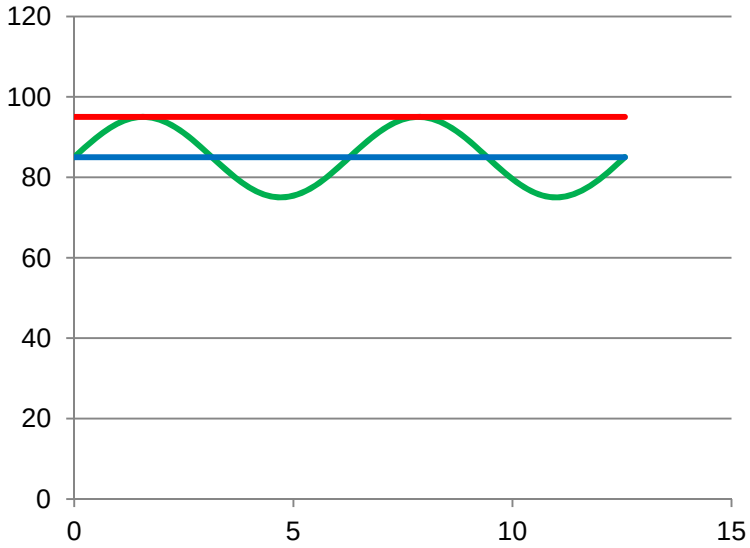
1. High process variability causes alarms.

   Operators shift the SP away from ideal to avoid these alarms ("comfort margin").

   - this will reduce efficiency resulting in lower throughput and higher consumption of energy and other utilities.




High variability: causes alarms...

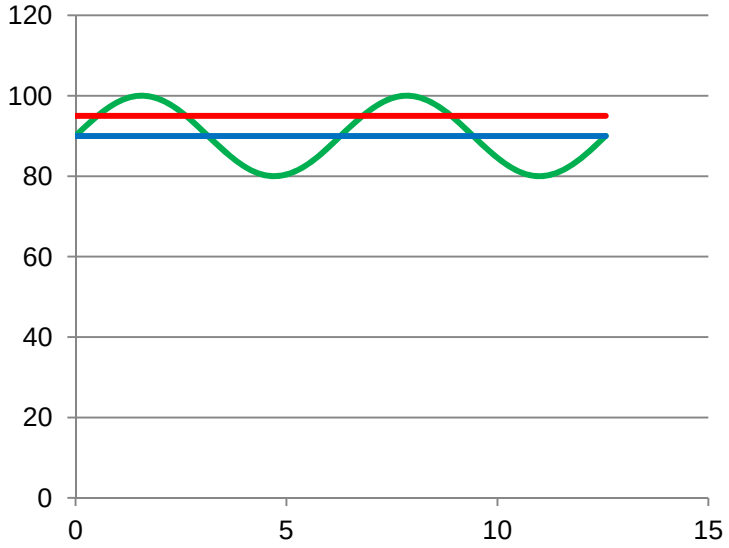

...so operators shift the setpoint

# Low Process Variability with Fieldbus

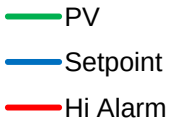
1. Set-point can be set closer to ideal.

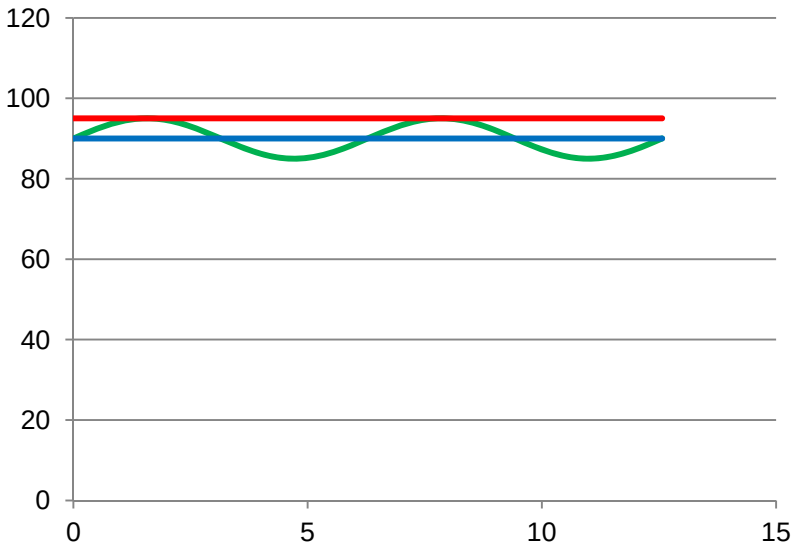
   This increases efficiency resulting in higher throughput and lower consumption of energy and other utilities.

   More uniform product; greater quality/yield.




High variability: causes alarms...




Low variability..set-point need not be changed.


**www.fieldbus.org**