Process Code and Monitor Code Logic

Larry Page & Kevin Batchelder

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Process Codes vs. Monitor Codes

Process codes and monitor codes provide information about other data ("metadata" = "data about data")

Process Codes describe the process state (startup, shutdown, etc.)

Monitor codes describe the validity of measured and calculated data points

What are Cedar Process Codes?

Process codes (PCs) indicate the state of the unit (or plant process) <u>relative to permit requirements</u> and exemptions

Process codes <u>categorize time periods</u> for different limits or operating conditions

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Available Process Codes

PCs are customized based on permit

Process Code	Description
3	Custom – typically Startup
4	Custom – typically Shutdown
8	Normal Operation
13	Process Offline
1, 2, 5, 6, 7, 9, 90 - 99	Custom

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Custom Process Codes

Depend on facility permit

- Cold Startup
- Hot Startup
- Warm Startup
- Turndown / Low Load
- Turbine Tuning
- Cleaning
- Others

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How are Process Codes used?

Examples
- Separate startup/shutdown data from normal-ops data
- Determine when startup limits apply
- Determine when normal limits apply
- Support permit-dependent logic

Note - PCs do not differentiate fuel usage (gas vs. oil, etc.)

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How are Process Codes stored?

Cedar defines tags for Process Code data
- ➢ Similar to NOx ppm tags, fuel flow tags, etc.
- ➢ Process Code data is available for
  - Realtime
  - 1-Minute
  - 1-Hour

How are Process Codes determined?

1. Inputs to CEMS PLC
   - Flame on
   - Fuel flow
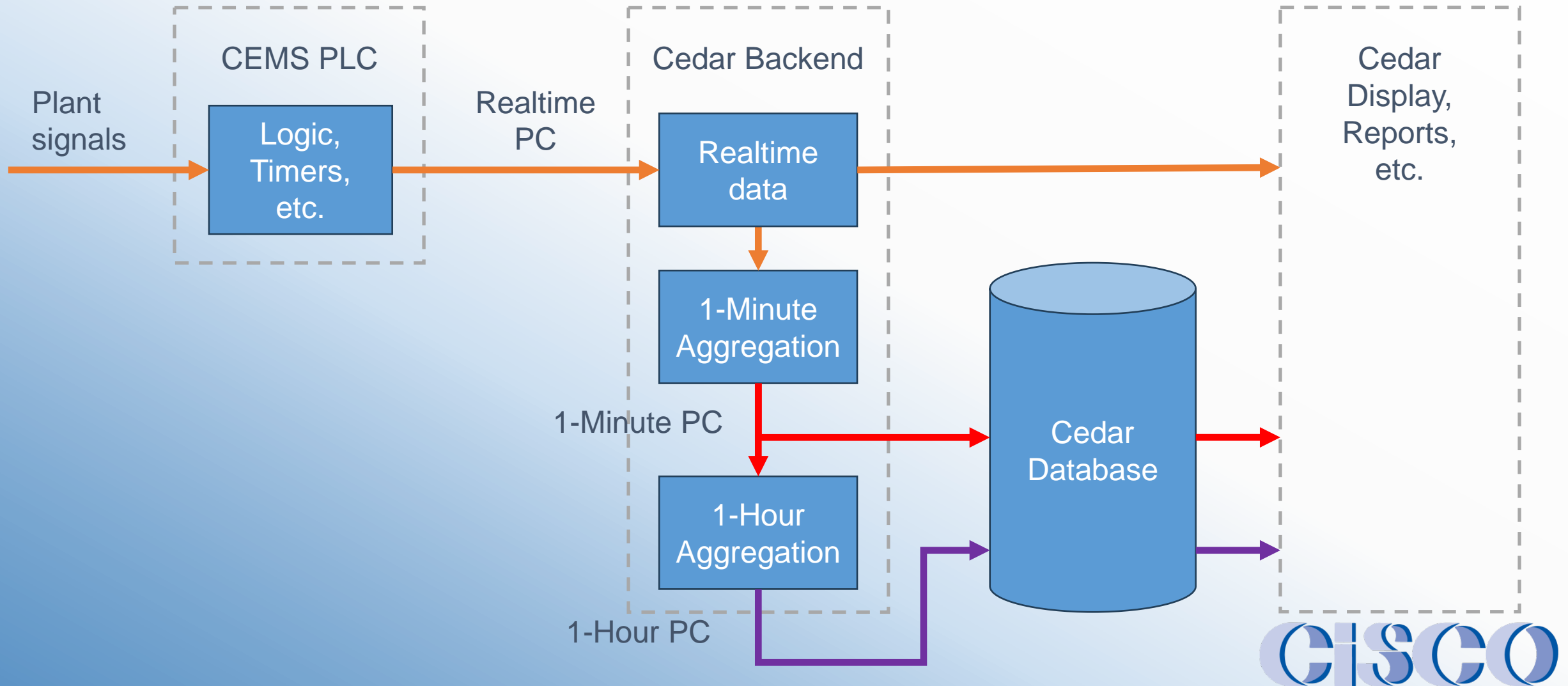   - O2
   - Others

2. PLC determines realtime process code
   - Setpoints
   - Timers
   - Other logic

3. Cedar reads realtime PC from CEMS PLC

4. Cedar produces 1-minute and 1-hour PCs

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Typical Process Code data flow

Shutdown "Backfill" in Cedar

Problem

How can PLC determine when shutdown <u>begins</u>??   (hard)

But…

How to determine when shutdown <u>ends</u>?   (easy)

>>> Unit is offline

Solution

- Cedar detects end of shutdown
- Cedar retroactively changes PC data to Shutdown
  - ➢ for previous X minutes (or other condition)
- Cedar recalculates affected data

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Process Code Aggregation

Aggregation summarizes 1-minute and 1-hour values from "smaller" data points

Not as simple as average or sum

Priority (lower-numbered PCs have higher priority)

Minimum quantity (X seconds of startup in minute, etc.) – depends on configuration

PC Aggregation Example

1-minute PCs in hour:

5 mins	PC 3	Startup
30 mins	PC 8	Normal
10 mins	PC 4	Shutdown
15 mins	PC 13	Offline

Aggregate to produce 1-hour PC:
Result = **PC 3 Startup**

(Why?) – Lowest numbered PC in hour wins

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Process Codes - Key Points

- Process codes indicate the state of the unit <u>relative to permit requirements</u> and exemptions

- Process codes <u>categorize time periods</u> for different limits or operating conditions

- Shutdown PC is backfilled at end of shutdown (typical)

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What are Cedar Monitor Codes?

A Monitor Code (MC) indicates the <u>validity</u> of a data point

Each data point has a <u>value</u> and a <u>monitor code</u>

Most Cedar tags have monitor codes
   Exceptions – process codes, on-times, settings/constants

Cedar Monitor Code categories

Each Monitor Code belongs to one of these categories

Category	Description
Valid	Unit online, data point is valid
Invalid	Unit online, data point is invalid
Offline	Unit offline, validity not specified

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Monitor Codes – Valid Data

Monitor Code	Description	Determined by
00	Normal	CEMS PLC
35	Over-range value replaced with 200% MPC ➢ Breeze: causes MODC 19 or 20	CEMS PLC, Cedar, User
38	Valid HDR data (PLC backup data)	CEMS PLC
40 - 52	Substitute data ➢ Data valid for calcs ➢ Counts as monitor downtime	Cedar

See documentation for full list

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Monitor Codes – Unit Offline

Monitor Code	Description	Determined by
13	Unit offline	CEMS PLC
29	Unit offline; CEMS in cal	CEMS PLC
39	Unit offline HDR data (PLC backup data)	CEMS PLC
60, 68	N/A (treat as unit offline for calcs) ➢ Exclude data from averages	Cedar
64	Unit offline; CEMS in maintenance	CEMS PLC
65	Unit offline; CEMS in backflush	CEMS PLC

See documentation for full list

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Common Monitor Codes – Invalid Data

Monitor Code	Description	Determined by
11, 12	Monitor OOC (failed cal check)	CEMS PLC
14	CEMS in cal	CEMS PLC
15, 20	CEMS in maintenance	CEMS PLC
16, 17	Analyzer fault	CEMS PLC
19	Sample handling malfunction	CEMS PLC
25	CEMS in backflush/purge	CEMS PLC

See documentation for full list

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Other Monitor Codes – **Invalid Data**

Monitor Code	Description	Determined by
18	DAHS malfunction (default) ➤ Don't know unit online/offline status	Cedar
33	Data not QA ➤ Failed or missing QA ➤ Use MC 33 when Breeze or ECMPS find QA requirements are not met	User
34	Not Sufficient Data "NSD" ➤ Averages without enough valid data	Cedar
74	Monitor OOC 4x PS ➤ Invalidate data back to previous Part 60 cal	Cedar

See documentation for full list

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Monitor Codes – why so many?

- Diagnostics – "why is this data invalid?"

- Regulations – data must be treated, reported, or flagged differently for certain conditions
  - ➢ Many reg-specific MCs (Part 75, SCAQMD, Part 60, etc.)

- Substituted data – what substitution method?

- Atypical data source (HDR – PLC backup data)

- PCs and MCs do not overlap, except 13 (offline)

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Monitor Code Combination

Calculations <u>combine 2 or more data points</u> into a new data point

When combining MCs from <u>different</u> categories
- Offline MCs   - highest priority
- Invalid MCs
- Valid MCs   - lowest priority

When combining MCs from <u>same</u> category
- Keep the <u>highest priority MC</u>
- See documentation for priority list

Monitor Code Combination

Example: Calculate NOx @ 15% O2

Inputs:
NOx   Valid (MC 00)
O2   Invalid (MC 12)

Result:
NOx @ 15% O2
                Invalid (MC 12)
(Why?) – invalid MC has higher priority than valid MC

Monitor Code Aggregation - 1

Aggregation summarizes 1-minute, 1-hour, 1-day, etc., data points from "smaller" data points

Cedar first determines ==validity== of aggregate period
- ➤ Is the period valid, invalid, or offline?
  - Period is online if any data valid or invalid
- ➤ Criteria may include
  - Minimum quantity (X valid data pts in hour, day, etc.)
  - Quadrant checks (X valid 15-min blocks in hour)
  - Exclude startup/shutdown data
  - Etc.

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Monitor Code Aggregation - 2

Next Cedar determines the aggregate <mark>monitor code</mark>

- Look at MCs with same validity (valid/invalid/offline) as the aggregate period
- Highest quantity wins
- Tiebreaker – Highest priority wins

Major exceptions:

- MCs 35,36 (200% MPC) win
- MCs 18,22 win only if nothing else available
- Quadrant checks: if period invalid, only consider invalid quadrants
- Quadrant checks: if period invalid, MC 11,12 win
- Rolling averages with insufficient data: MC 34 (NSD)

Monitor Code Aggregation - 3

Finally, Cedar determines which values to include in the aggregate <mark>value</mark>

Validity of period	Data points to include in aggregate value
Valid	All valid data points
Offline	All valid and offline data points
Invalid	All valid data points, if any Otherwise, all invalid data points

(Aggregate value, not monitor code)

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MC Aggregation Example

1-minute MCs in hour:

    30 mins   MC 00   Normal (valid)
        (cal started)
    20 mins   MC 14   CEMS in Cal (invalid)
        (cal failed; technician put CEMS out of service)
    10 mins   MC 20   Corrective Maintenance (invalid)

Aggregate to produce 1-hour MC:
    Result = **MC 14 CEMS in Cal**

    (Why?) – Hour is invalid; MC14 has highest quantity

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Monitor Codes - Key Points

- Monitor codes represent the <u>validity</u> of data points

- When combining or aggregating Monitor Codes, Cedar tries to select the MC that <u>best represents</u> the <u>validity</u> of the data

Process Code & Monitor Code Logic

Monitor Code and Process Code documentation is available at
http://downloads.ciscocems.com/downloads/Manuals/Monitor Codes and Process Codes.pdf

Questions?

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