# Traffic Types & their Mapping to TSN Mechanism

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# Background

To clarify queue set-up and TSN configuration, this contribution shows detail of traffic stream specifications for a system based on our last Bangkok meeting consensus.

# Outline

1. Base use case
2. System components, connection, streams
3. Traffic type and traffic class
4. Queue setup and TSN configuration for constrained bridge
5. Conclusions

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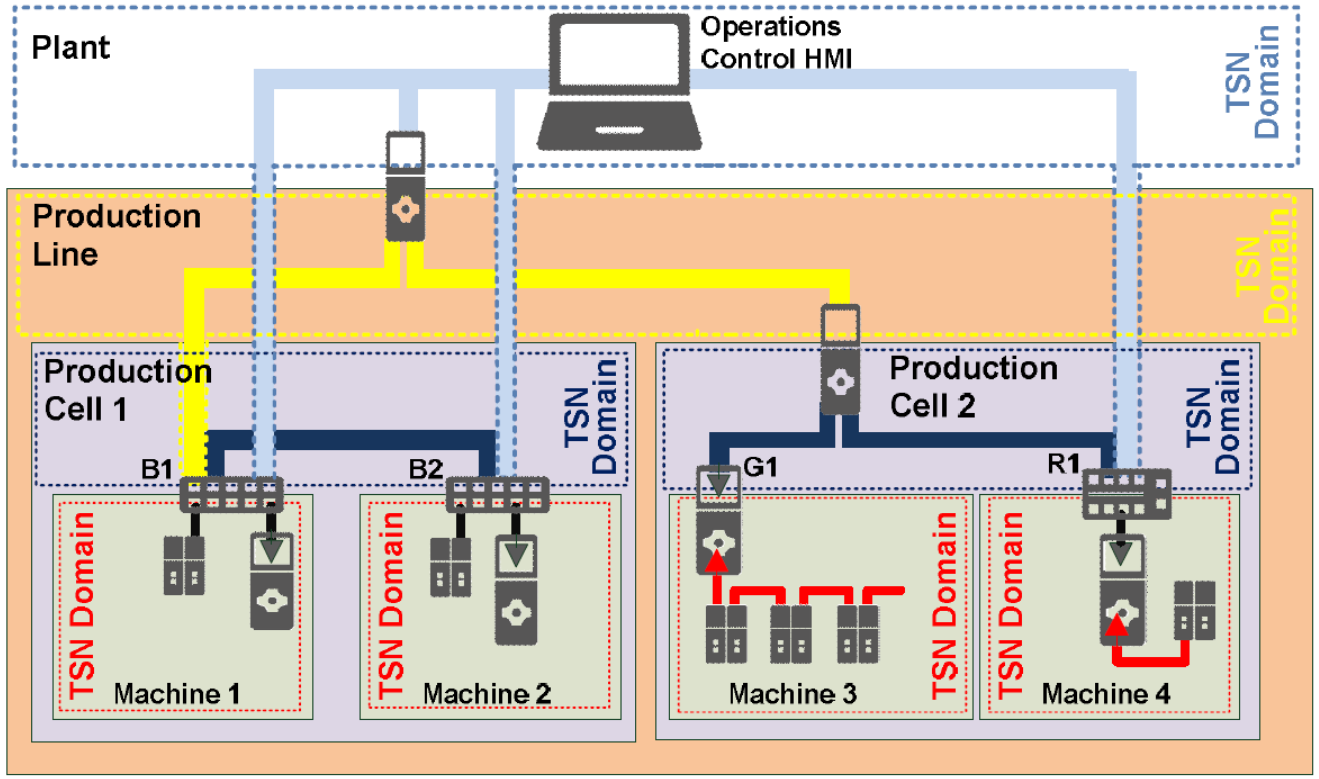
# M2M use case (U-17)



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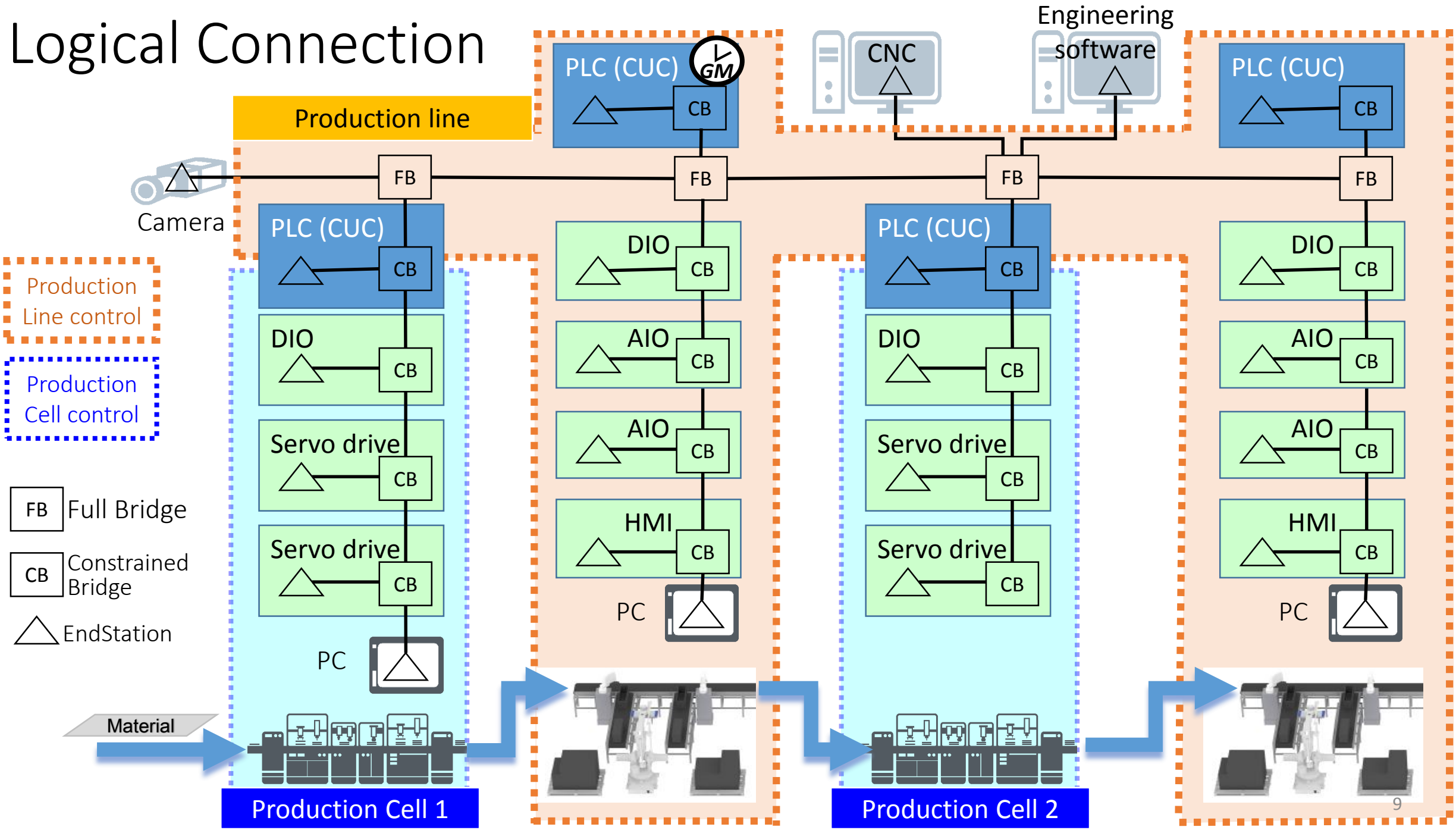
# System Components

- CNC
- CUC in PLCs
- Devices for Production Line
- Devices for Production Cells
- Engineering software workstation
- Grand master in PLC
- IP video camera
- PC for Production Line/Cell monitoring

# Logical Connection



# Streams in this system

1) Streams for **PLC  Config. & Diag.**

2) Streams for **FB/CUC  Config. & Diag.**

3) Streams for **Production Line control (Controller-Controller)**

4) Streams for **Production Line control (IO control)**

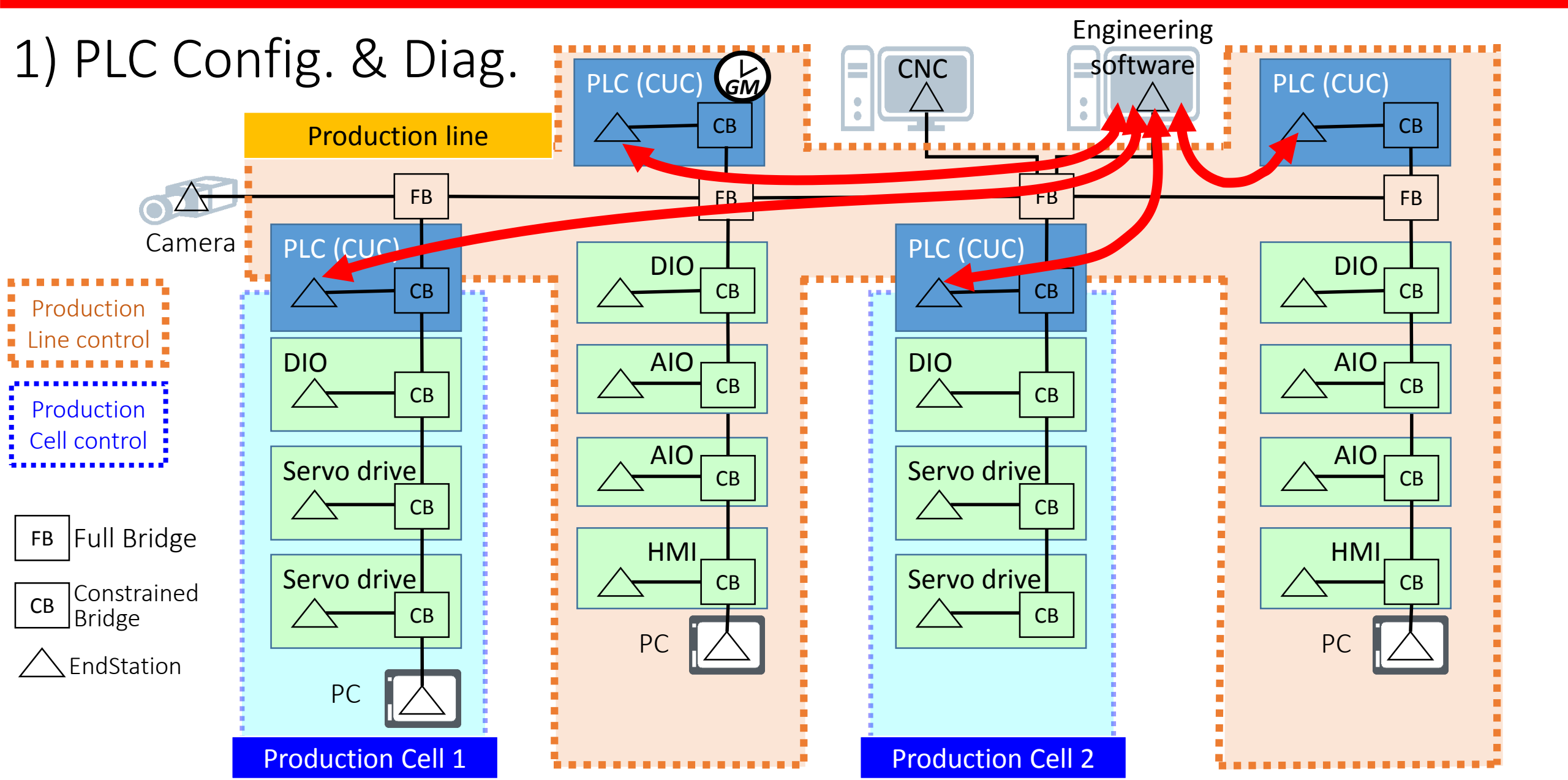
5) Streams for **Production Cell control (Motion control)**

# Streams in this system

1) Streams for **PLC  Config. & Diag.**

   (a) Sporadic communication between Engineering software and PLC

# 1) PLC Config. & Diag.



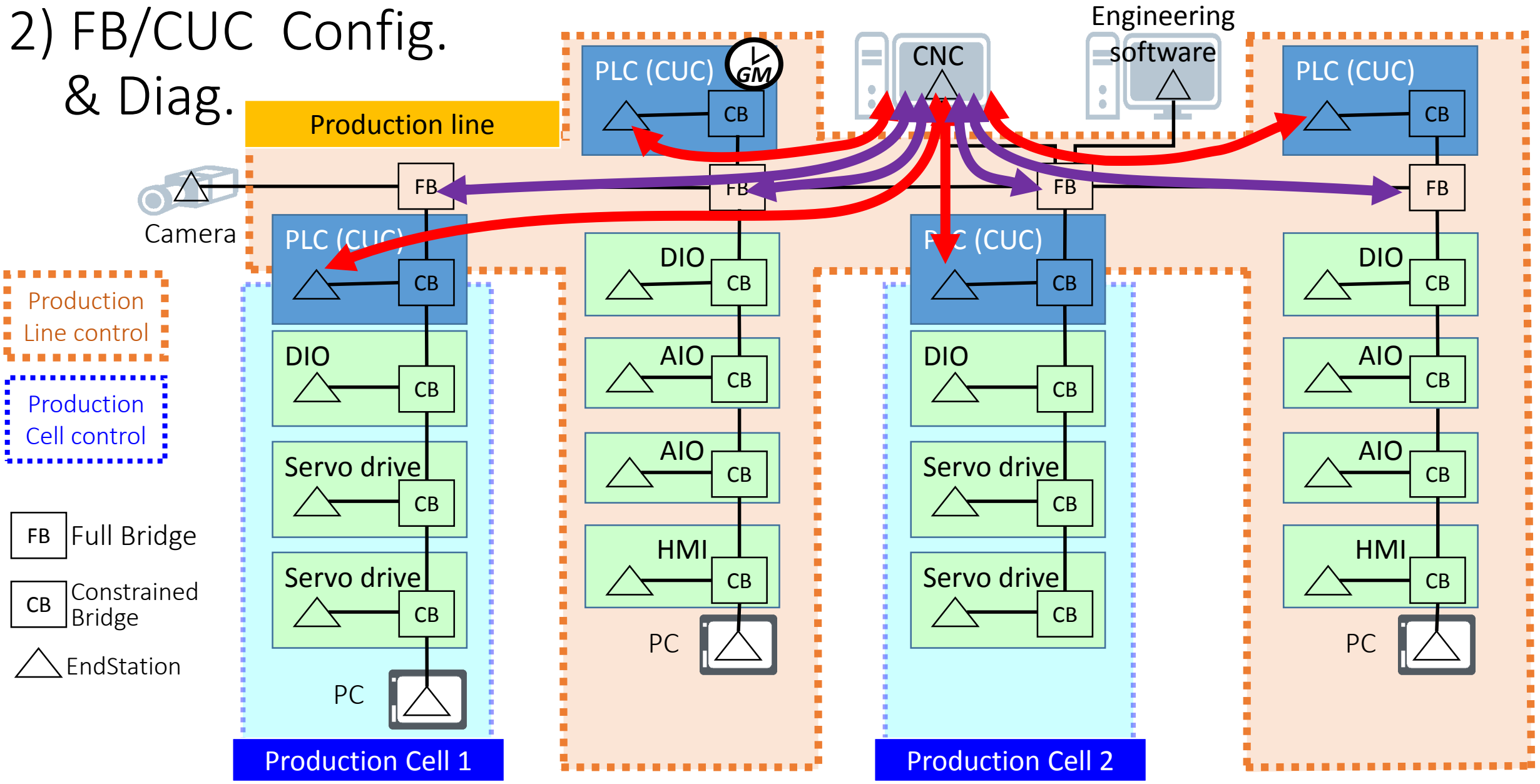
# Streams in this system

2) Streams for **FB/CUC Config. & Diag.**

(a) Sporadic communication between CNC and FB, including LLDP

(b) Sporadic communication between CNC and CUC in PLC

# 2) FB/CUC Config. & Diag.



# Streams in this system

3) Streams for **Production Line control (Controller-Controller)**

(a) Periodic communication for Time synchronization

(b) Cyclic communication between controllers

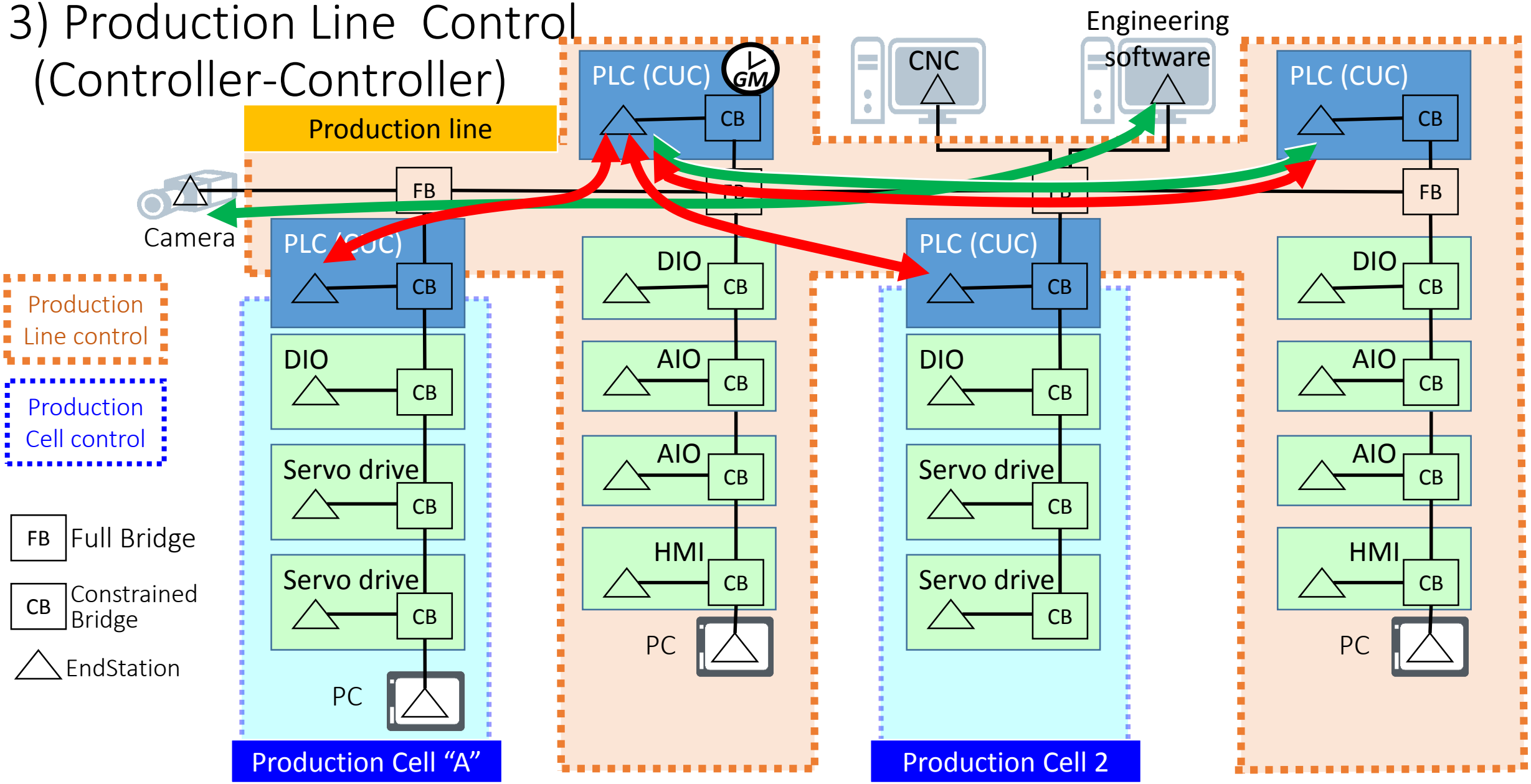
(c) Sporadic communication for Config. between CUCs in PLC

(d) Sporadic communication for Diag. between PLCs

(e) Sporadic TCP/IP communication with PLCs etc.

(f) Bursty UDP/IP communication with Camera etc.

# 3) Production Line Control (Controller-Controller)



# Streams in this system

4) Streams for **Production Line control (IO control)**

(a) Periodic communication for Time synchronization

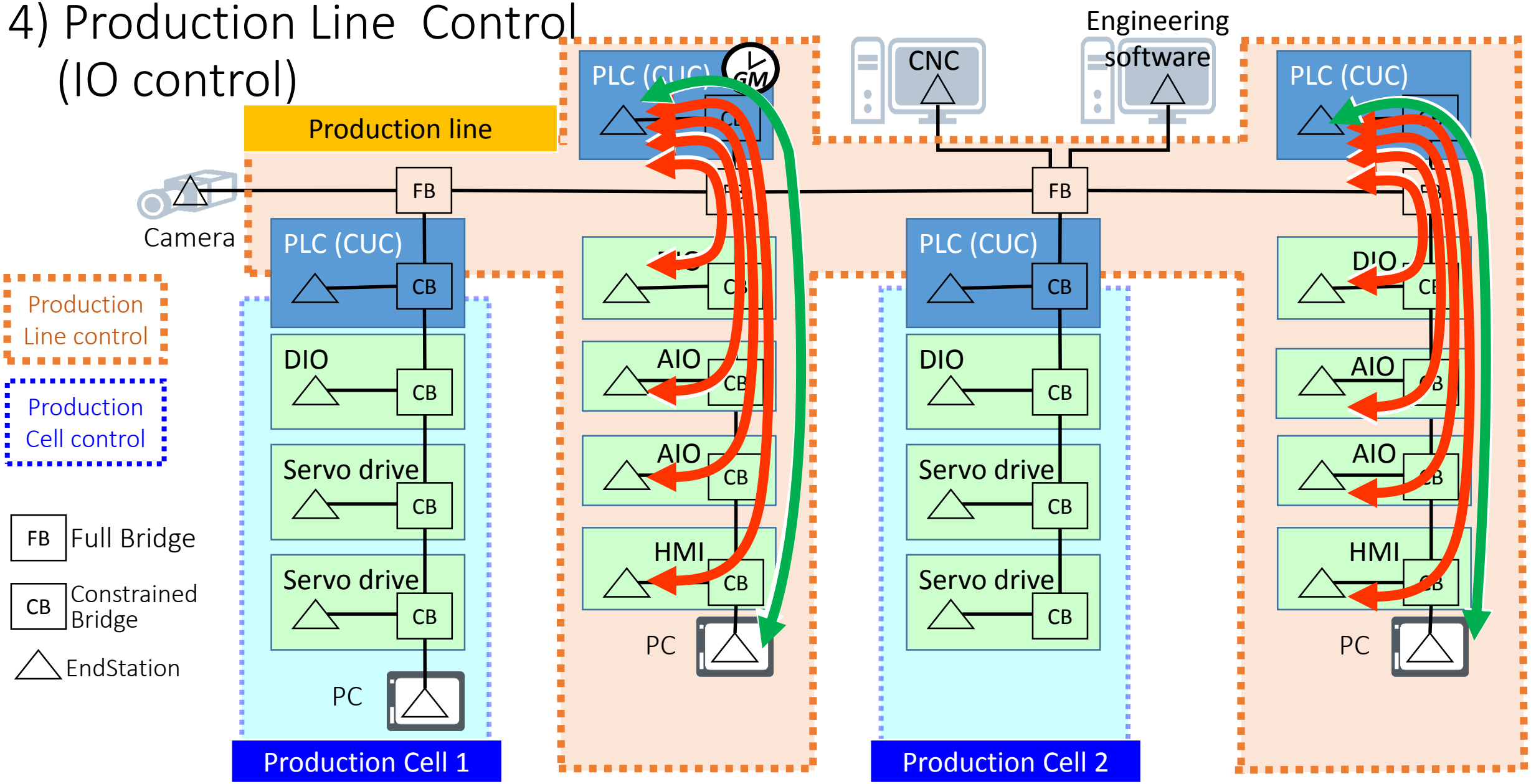
(b) Cyclic communication for IO control

(c) Sporadic communication for Config. between CUC in PLC and other devices

(d) Sporadic communication for Diag. between PLC and other devices

(e) Sporadic TCP/IP communication with PCs etc.

# 4) Production Line Control (IO control)



# Streams in this system

5) Streams for **Production Cell control (Motion control)**

(a) Periodic communication for Time synchronization

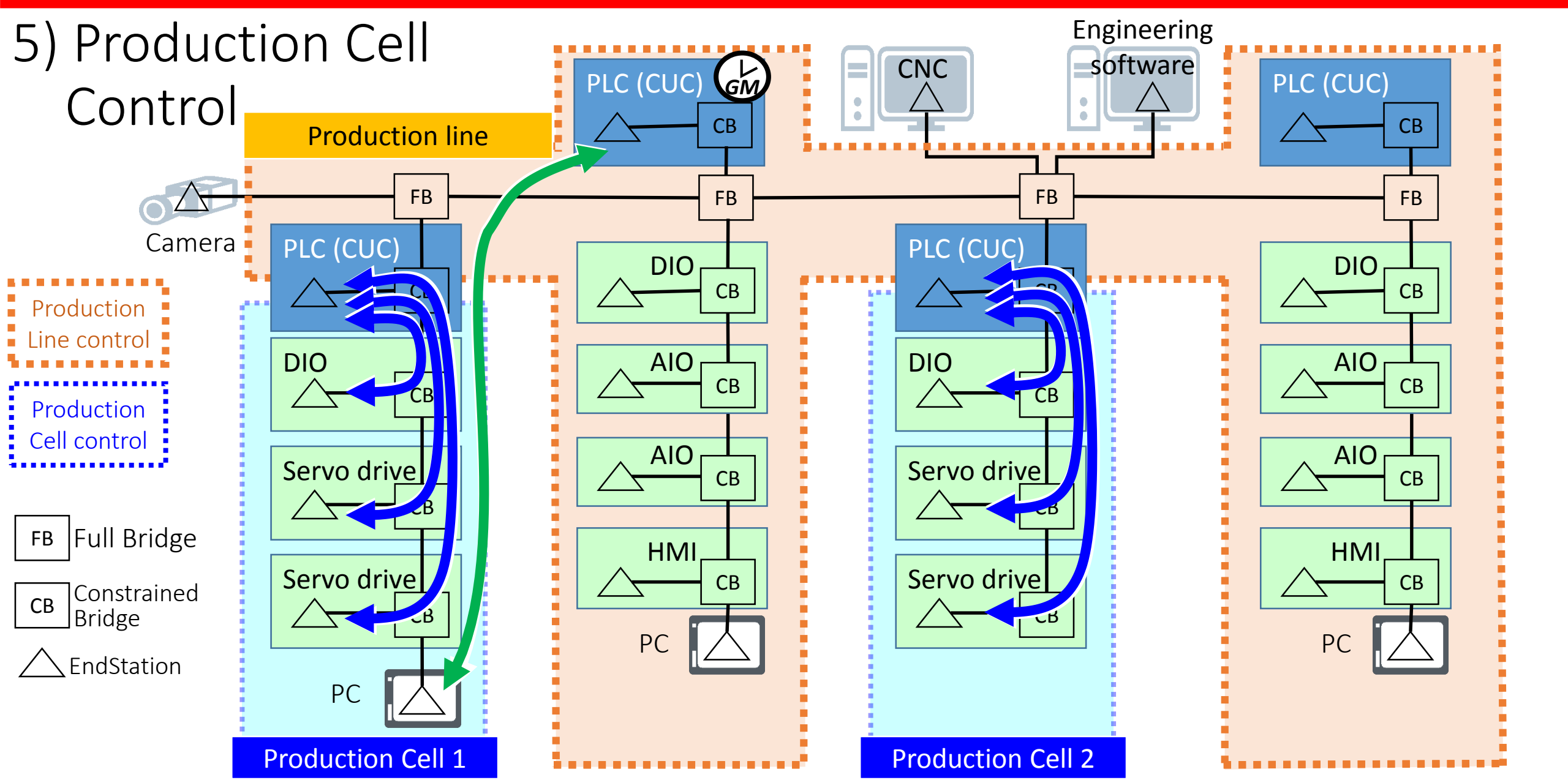
(b) Isochronous communication for Motion control

(c) Sporadic communication for Config. between CUC in PLC and other devices

(d) Sporadic communication for Diag. between PLC and other devices

(e) Sporadic TCP/IP communication with PC etc.

# 5) Production Cell Control



# Stream characteristics in this system

| No. | Types | Periodicity | Typical period | Synchronized to network | Data delivery guarantee | Tolerance to interference | Tolerance to loss | Typical application data size | Criticality |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Isochronous | Periodic | 31.25us - 2ms | Yes | Deadline | 0 | None | Fixed: 74-114 octet | High |
| 2 | Cyclic | Periodic | 500us - 100 ms | No | Latency | <= latency | 1 - 4 Frames | Fixed: 74 - 1500 octet | High |
| 3 | Events | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 4 | Network Control | Periodic | 16ms - 1 s | No | Bandwidth | Yes | Yes | Variable: 46 - 1500 octet | High |
| 5 | Config.& Diagnostics | Sporadic | N/A | No | Bandwidth | N/A | Yes | Variable: 46 - 1500 octet | Medium |
| 6 | Best Effort | Sporadic | N/A | No | None | N/A | Yes | Variable: 46 - 1500 octet | Low |
| 7 | Video | Periodic | ~33ms | No | Latency | N/A | Yes | Variable: 1000 - 1500 octet | Low |
| 8 | Audio/Voice | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

Event information are mapped to isochronous and cyclic streams so we don’t have Events traffic type in the table

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# Needed traffic types in this system

| No. | Traffic Types | Streams in this use case | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1) PLC Config. & Diag. | 2) FB/CUC Config. & Diag. | | 3) Production Line control (Controller- Controller) | | | | | | 4) Production Line control (IO control) | | | | | 5) Production Cell control (Motion control) | | | | |
| | | | (a) | (b) | (a) | (b) | (c) | (d) | (e) | (f) | (a) | (b) | (c) | (d) | (e) | (a) | (b) | (c) | (d) | (e) |
| 1 | **Isochronous** | | | | | | | | | | | | | | | | x | | | |
| 2 | **Cyclic** | | | | | x | | | | | | x | | | | | | | | |
| 3 | Events | | | | | | | | | | | | | | | | | | | |
| 4 | **Network Control** | | | | x | | | | | | x | | | | | x | | | | |
| 5 | **Config.& Diagnostics** | x | x | x | | | x | x | | | | | x | x | | | | x | x | |
| 6 | **Best Effort** | | | | | | | | x | | | | | | x | | | | | x |
| 7 | **Video** | | | | | | | | | x | | | | | | | | | | |
| 8 | Audio/Voice | | | | | | | | | | | | | | | | | | | |

Needed traffic types

# Needed traffic class in this system

| No. | Traffic Types | Traffic Class | Streams in this use case | | | | |
|---|---|---|---|---|---|---|---|
| | | | 1) PLC Config. & Diag. | 2) FB/CUC Config. & Diag. | 3) Production Line control (Controller-Controller) | 4) Production Line control (IO control) | 5) Production Cell control (Motion control) |
| 1 | **Isochronous** | **TC4** | | | | | x |
| 2 | **Cyclic** | **TC3** | | | x | x | |
| 3 | Events | - | | | | | |
| 4 | **Network Control** | **TC1** | | | x | x | x |
| 5 | **Config.& Diagnostics** | **TC0** | x | x | x | x | x |
| 6 | **Best Effort** | | | | x | x | x |
| 7 | **Video** | **TC2** | | | x | | |
| 8 | Audio/Voice | - | | | | | |

- Priority of TC: [High] TC4 > TC3 > TC2 > TC1 > TC0 [Low]
- TC7 to TC5 are not used.

Needed Traffic Types & Classes

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# Queue set-up

- Min. 4 Traffic Classes are needed.
  - Streams for PLC Config. & Diag. need only TC0.
  - Streams for FB/CUC Config. & Diag. need only TC0.
  - Streams for Production Cell control need TC4, TC1 & TC0
  - Streams for Production Line control need TC3, TC1 & TC0

TC4: Isochronous, TC3: Cyclic, TC1: TimeSync, TC0: Best effort

* Video camera is connected to full bridge so constrained device does not care about it

# Queue set-up

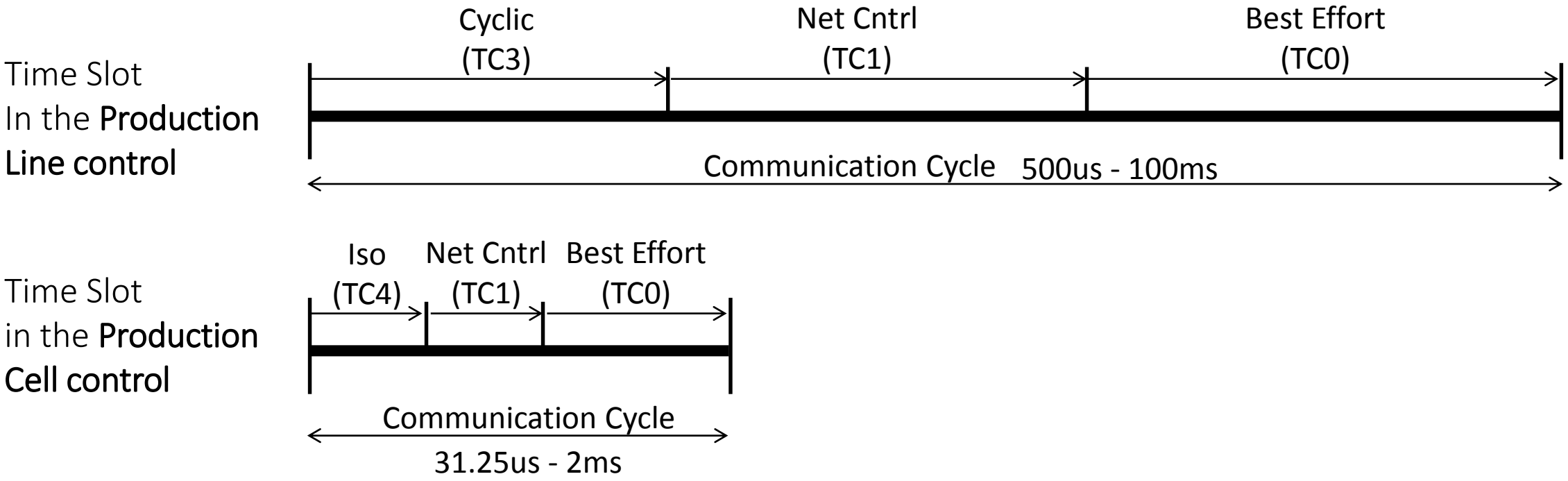
- CB which connects with both Production Cell and Line control covers all Traffic Classes

Queue setup example)

| Queue ID | Traffic Class for Production Cell control | Traffic Class for Production Line control | Traffic Class for both of Production Cell & Line control | Minimum Buffer size | Scheduling |
|---|---|---|---|---|---|
| 7-4 | Not used | Not used | Not used | N/A | TAS |
| 3 | TC4 | N/A | TC4 | 64 octet | |
| 2 | N/A | TC3 | TC3 | 64 octet | |
| 1 | TC1 | TC1 | TC1 | 2048 octet | |
| 0 | TC0 | TC0 | TC0 | 2048 octet | |

# Qbv transmission selection timing set-up

- This system synchronizes bridges by 802.1AS
- The production line control and the cell control can have different time slot set-up.



# Conclusions

- The shown system contains production cell control and production line control.
- The streams in this system are categorized as six traffic types.
- Four queues are sufficient to assign streams in constrained bridge.
- This system demonstrates one instance of transmission selection based on 802.1Qbv.
- Both 802.1Qbv and 802.1AS are necessary and sufficient for constrained bridge to control the streams in the shown system.

*Thank you very much for your attention.*

# Appendix) Full bridge Queue set-up example

- Max. 5 Traffic Classes are needed.
  - Streams for PLC Config. & Diag. need only TC0.
  - Streams for FB/CUC Config. & Diag. need only TC0.
  - Streams for Production Cell control need TC4, TC1 & TC0
  - Streams for Production Line control need TC3, TC1 & TC0
  - Stream for video need only TC2

# Appendix) Full bridge Queue set-up example

- FB covers all Traffic Classes.

Queue setup example)

| Queue ID | Traffic Class for Line control | Minimum Buffer size | Scheduling |
|---|---|---|---|
| 7-5 | Not used | N/A | TAS |
| 4 | TC4 | 64 octet | |
| 3 | TC3 | 64 octet | |
| 2 | TC2 | 2048 octet | |
| 1 | TC1 | 2048 octet | |
| 0 | TC0 | 2048 octet | |