Link startup and recovery timings
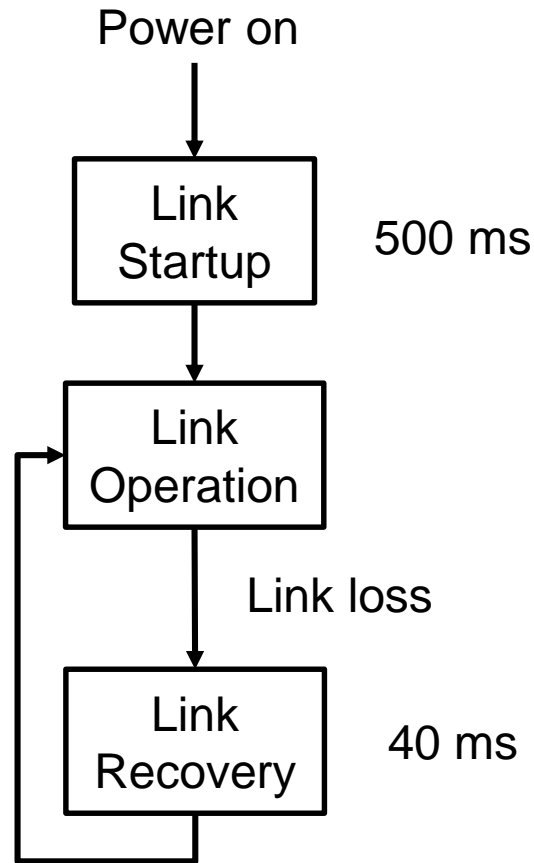
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Purpose

- A prior submission:
  - http://www.ieee802.org/3/10SPE/public/adhoc/1016_cg_adhoc_contribution%20Objectives_Winkel_r04.pdf

- Proposed the following general objective:
  - 15. Support fast startup and link loss recovery operation

- The purpose of this submission is to propose specific timing objectives

Proposed operation

Power on

```
        │
        ▼
   ┌──────────┐
   │   Link   │
   │  Startup │    500 ms
   └──────────┘
        │
        ▼
   ┌──────────┐
   │   Link   │
   │ Operation│
   └──────────┘
        │
        │  Link loss
        ▼
   ┌──────────┐
   │   Link   │
   │ Recovery │    40 ms
   └──────────┘
```

Link startup time

- Volume 2: EtherNet/IP Adaptation of CIP, Appendix E: EtherNet/IP QuickConnect™
  - www.odva.org

- "Automotive applications, robots, tool changers and framers are required to quickly exchange tooling fixtures which contain a section or segment of an [unpowered] industrial network."

- "need to be able to achieve a logical connection to the controller and test the position of the tool in less than 1 second from the time the tool and the robot make an electrical connection."

- "QuickConnect connection time is 500ms … defined as the guaranteed repeatable time between the electrical contact of power and Ethernet signals at the tool changer, and when the newly connected devices are ready to send the first … I/O data packet."

Robotic End-of-Arm Tooling
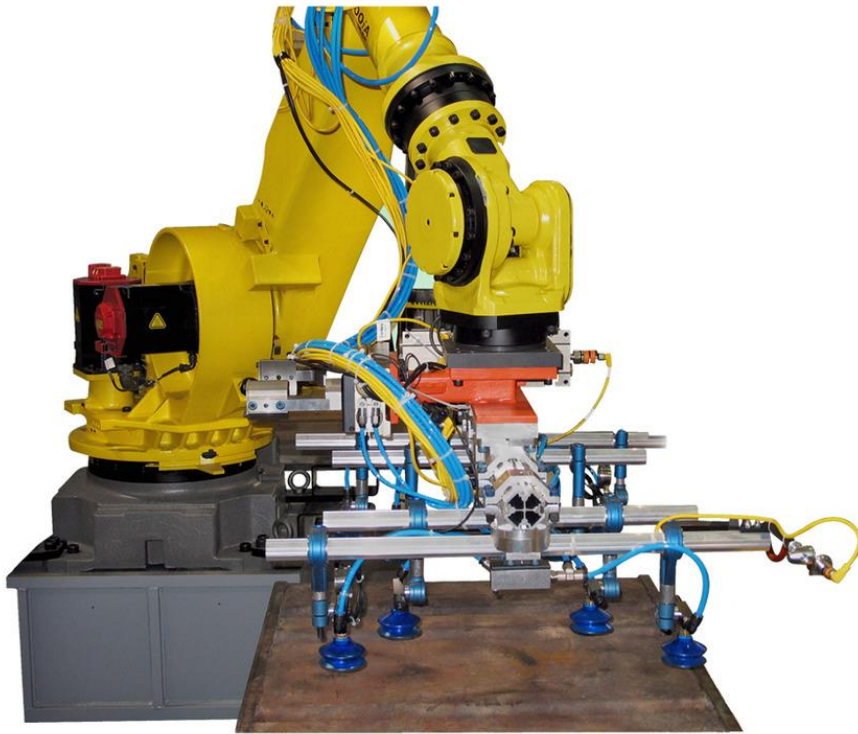
- Generic robot arm
- Multiple sets of tooling are exchanged as needed
- Tooling is <u>unpowered</u> when the robot attaches
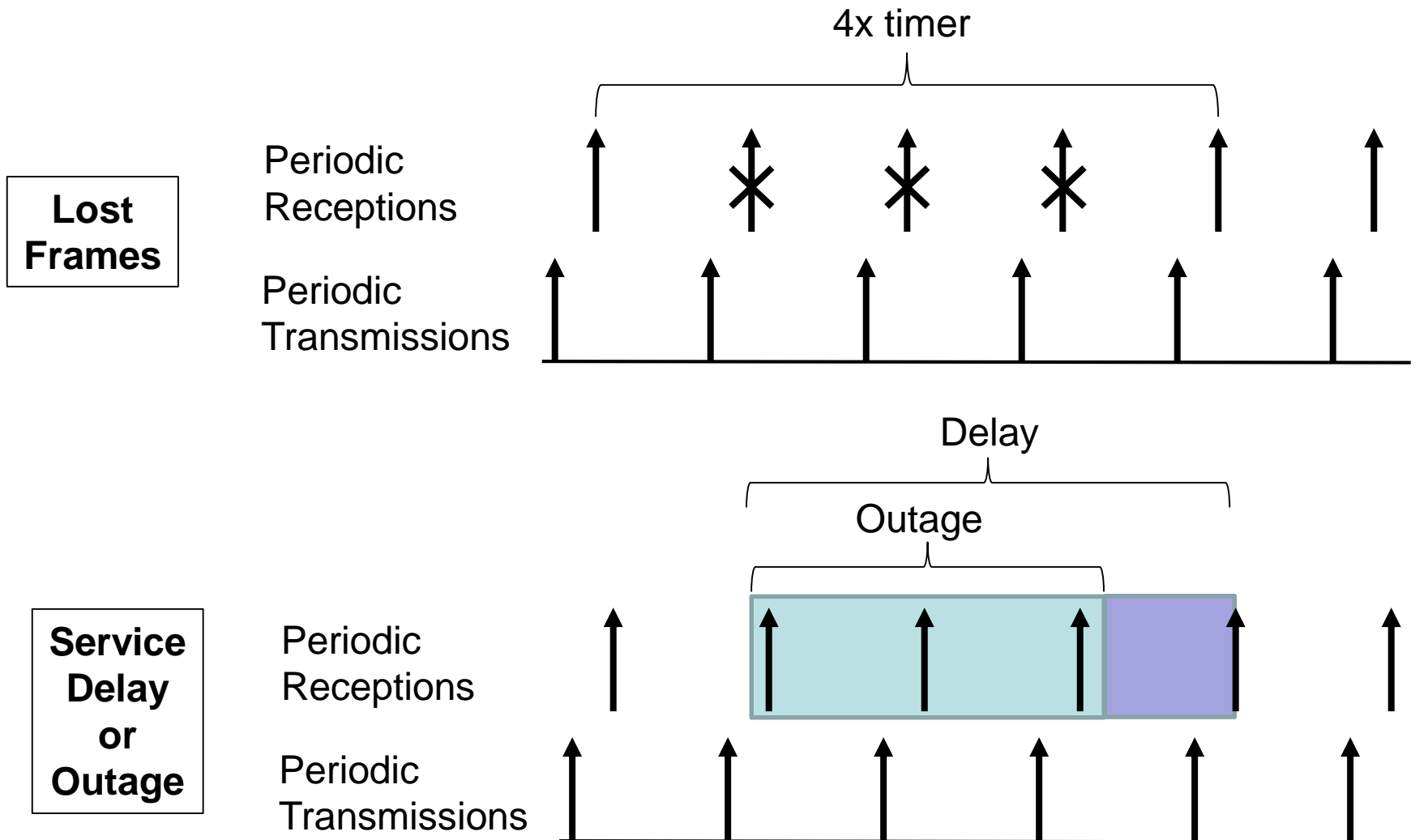- Tooling changeover time affects production efficiency

Link recovery time

- Prior submission described the results of connection loss:
  - http://www.ieee802.org/3/10SPE/public/adhoc/brandt_082216_10SPE_01_adhoc.pdf

- Automation must maintain knowledge of the state of the system
  - Through periodic updates on a "connection"
- If any connection is lost, a fault may occur:
  - Human intervention may be required
    - Unjam equipment
    - Rerun safety procedures
  - Product may be lost
- Timeout should not typically be less than 4x the update period (high BER sensitivity)

Link recovery time

- Prior submission:
  - http://www.ieee802.org/3/10SPE/public/adhoc/brandt_082216_10SPE_01_adhoc.pdf

- Control protocols use oversampling techniques to tolerate message loss

- Describes the result of connection loss:
  - Automation must maintain knowledge of the state of the system
    - Through periodic updates on a "connection"
  - If any connection is lost, a fault may occur:
    - Human intervention may be required
      - Unjam equipment
      - Rerun safety procedures
    - Product may be lost

Connection loss mechanisms

4x timer

Lost Frames

Periodic Receptions

Periodic Transmissions

Delay

Outage

Service Delay or Outage

Periodic Receptions

Periodic Transmissions

Protocol tolerance

- Periodic updates and timeout is 4x the update period
    - Less than 3 frames lost in a row
    - Delays less than 3x the update period
    - <u>Outages less than 2x the update period</u>

- A common default update period is 20 ms
    - Faster applications are expected to use faster versions of Ethernet
    - Link loss recovery should be 40 ms

Applicability

- Several of the fieldbuses mentioned in the CFI, especially for Factory Automation
  - CANopen, CC-Link, DeviceNet, ControlNet, INTERBUS, PROFIBUS DP

Conclusions

- A 500 ms link startup time is required in certain industrial automation applications

- A 40 ms link loss recovery is required in a large portion of industrial automation applications

- Proposed objective:
  - 15. Support ~~fast~~ <u>500 ms link</u> startup and <u>40 ms</u> link loss recovery operation