

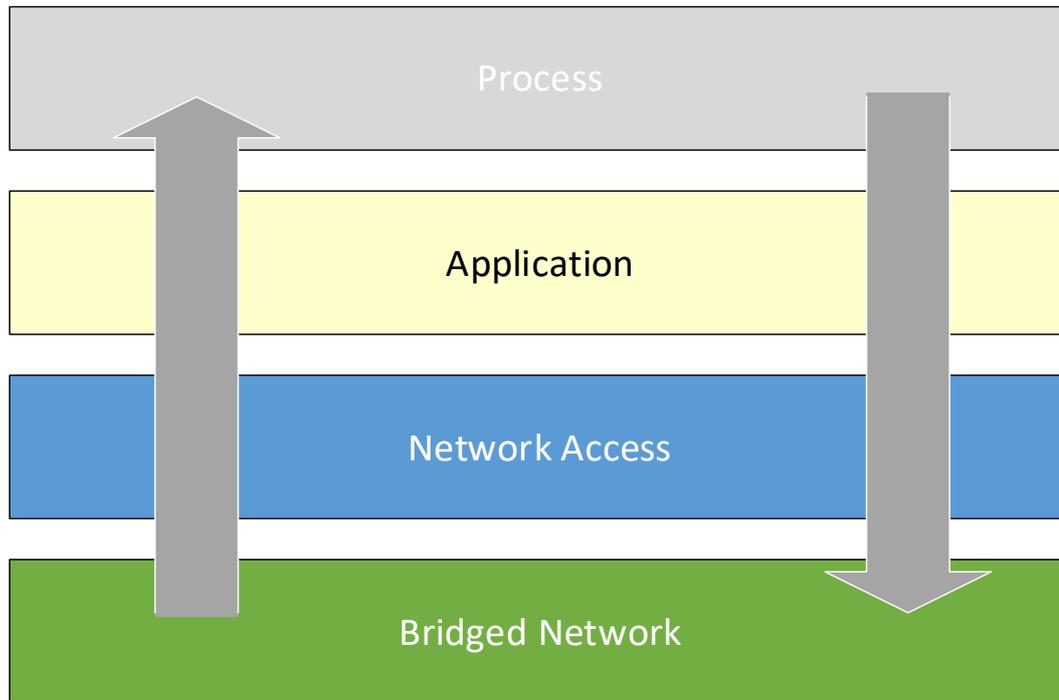
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Application Timing models

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Scope



This contribution covers one application timing model¹⁾ used in automation together with industrial communication.

Its roots are quite deep into the development of industrial communication over time and ensures customer application compatibility.

The implemented timing model itself covers the path from process to process. This contribution excludes the process and covers the path from application to application.

Historic basis

Moving from parallel to sequential control raised the problem of the data basis for the program execution together with its execution speed.

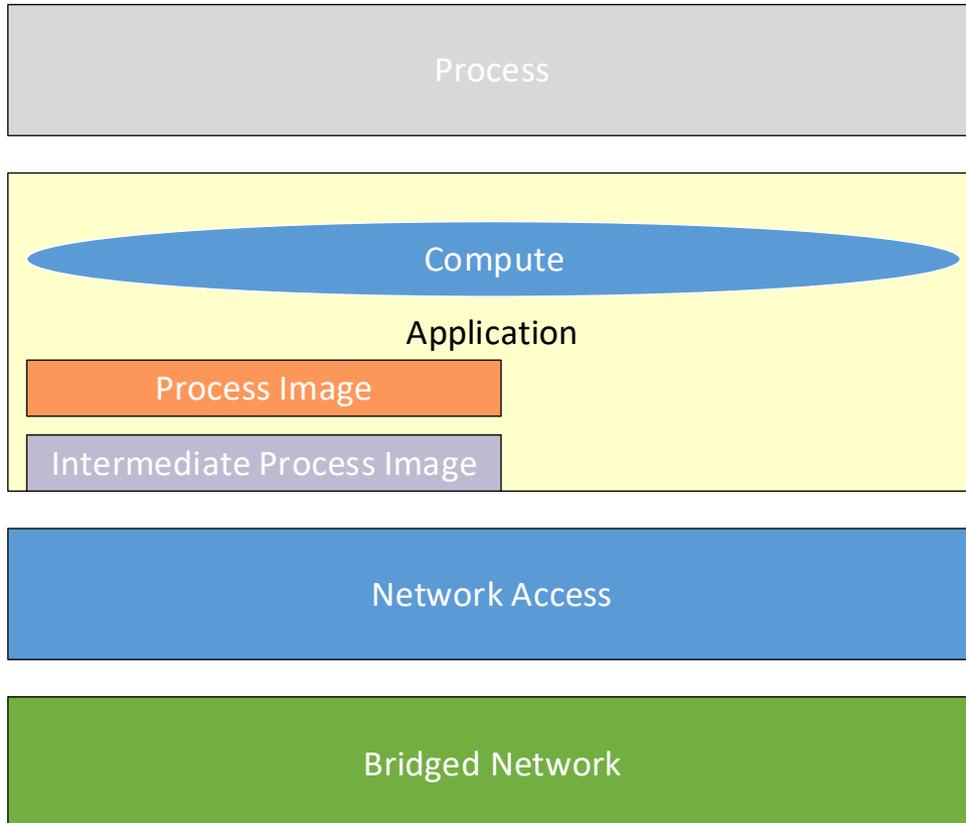
That led to the implementation of so called process images, which were in the beginning only a few bytes in size.

Basic timing model – fetching inputs, writing outputs, compute, repeat

Increasing the available memory, the available compute, the amount of connected IOs, integrating motion and of remote IOs just extended this basic model.

Always ensuring that the customer applications are running unchanged!

Details



Nowadays, the process image has a size from less than 1k Bytes up to 1M Byte.

This amount of data, provided by up to 1024 communication partners, takes some time to be collected.

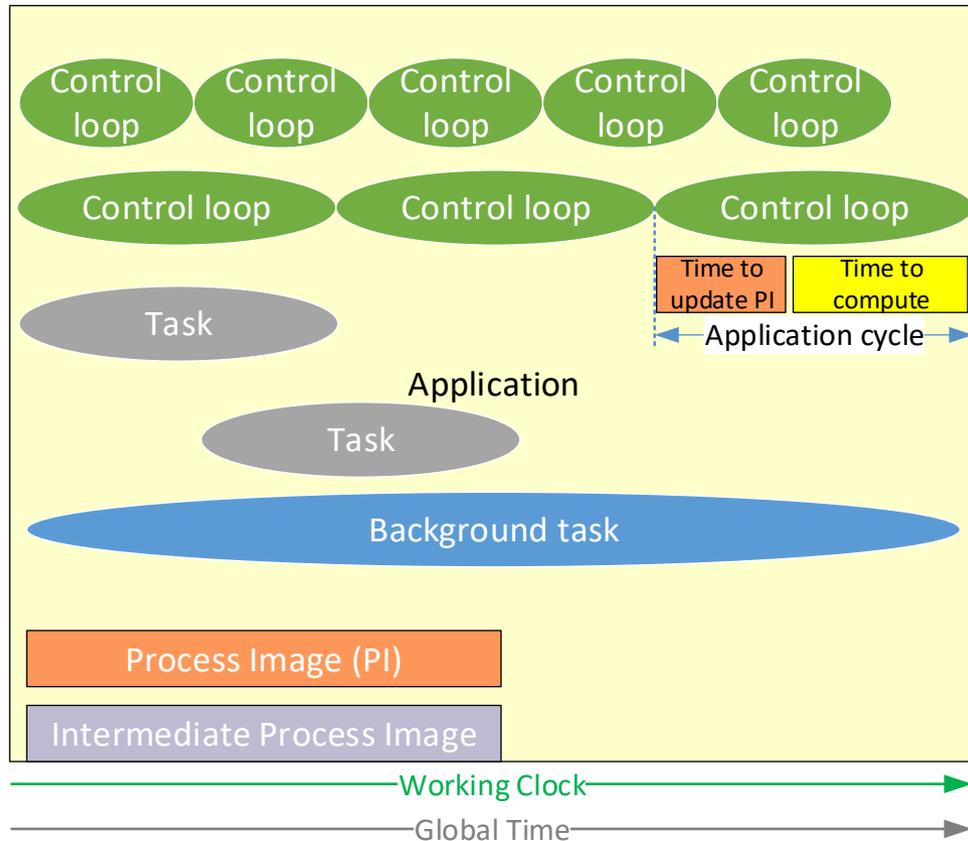
Applications require update times of their portion of the process image from 25 μ s/31,25 μ s up to 1s.

Thus, the update of the Process Image and the Network Access interact to support the requirements for timeliness from the applications.

Compute contains the background task, which creates the trigger for the update of the process image from the intermediate process image.

Additionally, many time triggered tasks, either by working clock or global time are executed concurrently.

Application



Background task, Time event task and Control loop tasks are started time triggered.

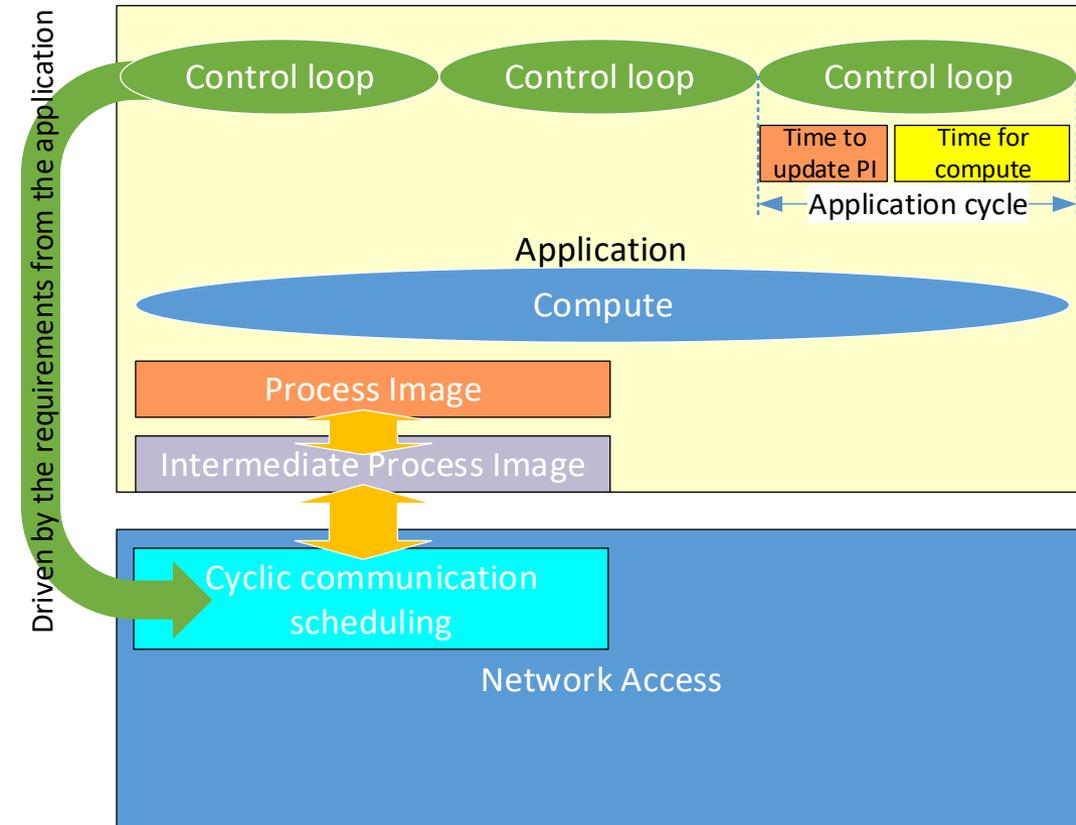
Background and time event tasks by Global Time (e.g. every noon do something), even if global time is locally managed in the PLC.

Control loop tasks are Working Clock triggered, sometimes, when e.g. in process automation, the timing requirements are very relaxed, without global synchronized Working Clock.

Each task follows the same principle

1. Start due to time event
2. Update the Process Image by copying the data from the Intermediate Process Image
3. Compute the control loop
4. Repeat

Interaction between Application and Network Access



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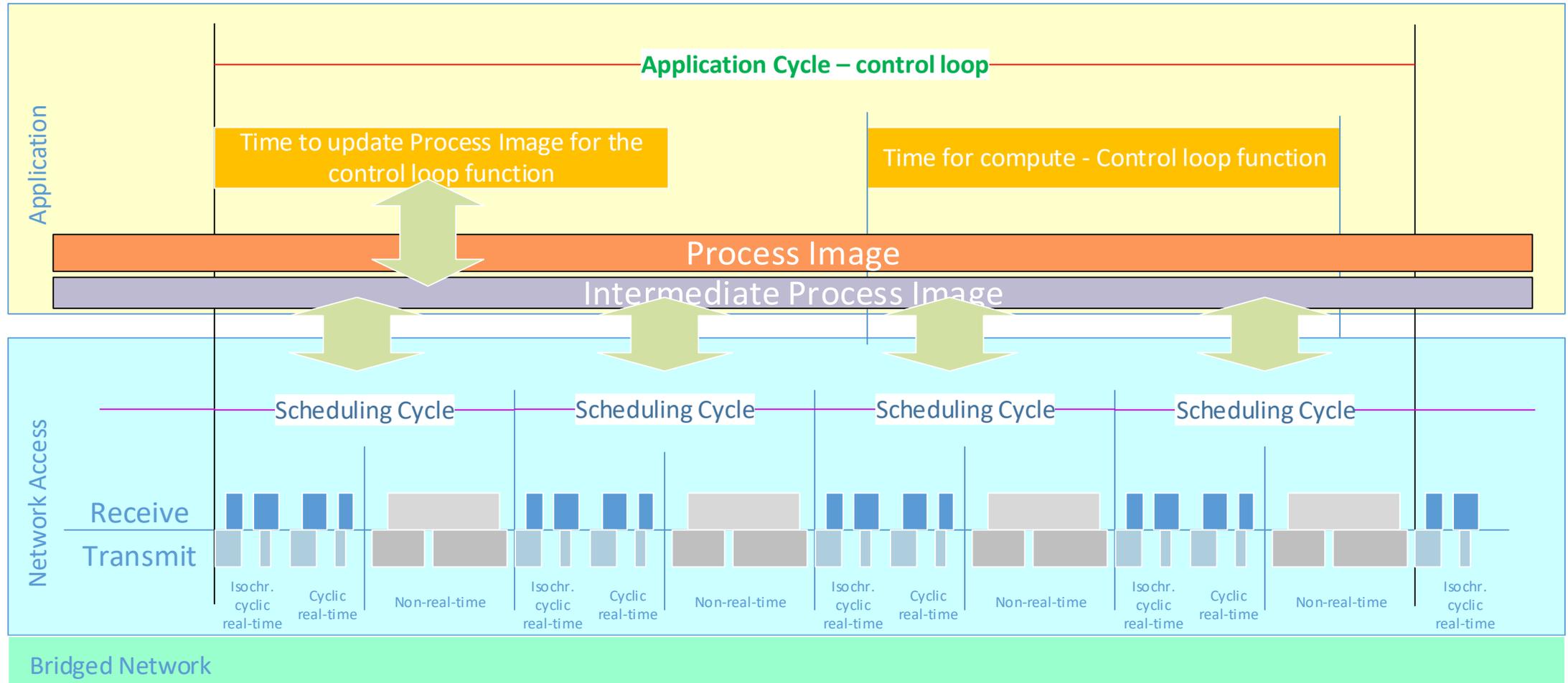
Thus, the update of the Process Image and the Network Access interact to support the requirements for timeliness from the applications.

All the different requirements of the installed applications, including the background task, are used to create a scheduling for the streams used to update the Process Image.

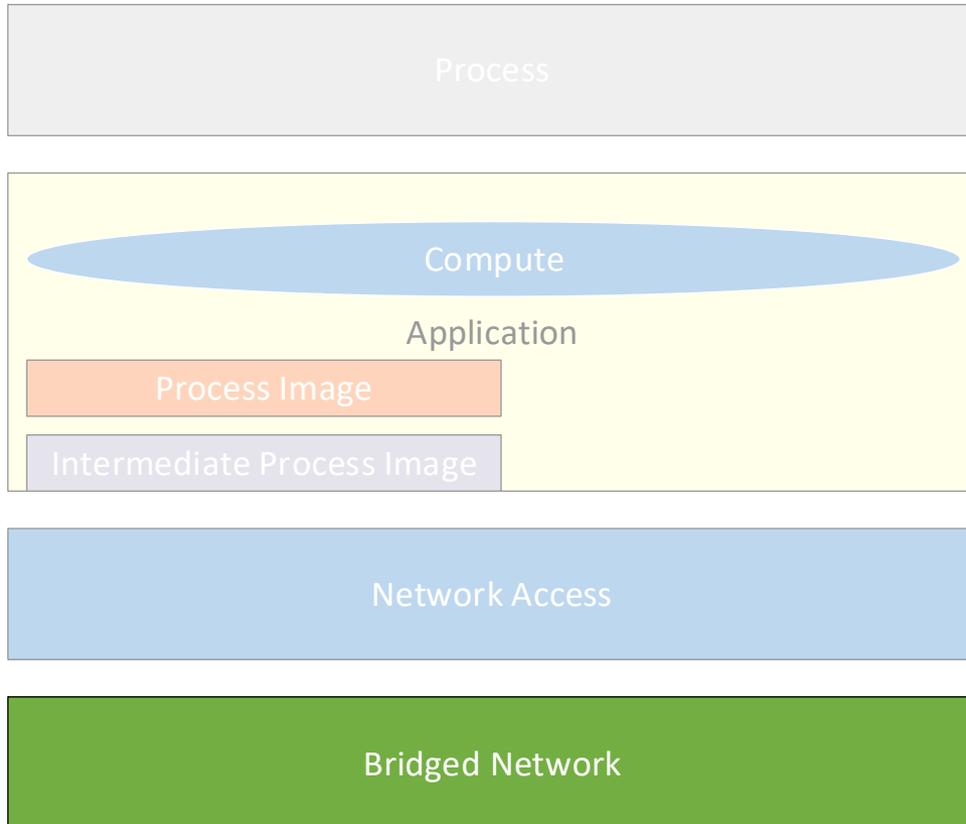
The cyclic communication scheduling organizes the communication by interlacing the streams for application with shorter application cycles with those with longer application cycles.

The cyclic communication scheduling includes the resource protection of the egress ports.

Example for cyclic communication scheduling



Bridged network



The bridged network shall provide

- Support of synchronization with an accuracy of $|1\mu\text{s}|$
- Support of zero congestion loss
- Support of bounded latency
- Support for seamless redundancy
- Fitting bandwidth

summarized as “requested QoS for applications”.

The application is decouple from the bridged network through the network access, which covers the scheduling for the cyclic communication.

Conclusion

The amount of cyclic exchanged data and the required application cycles need to be covered by the solution for the Network Access.

Interlacing the different streams used for cyclic exchanged data together with resource protection for zero congestion loss in the bridged network requires a scheduling at the network access.

This seems to be a feasible solution for these industrial requirements.

Questions?