IEC/IEEE 60802
Application Timing models

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Scope

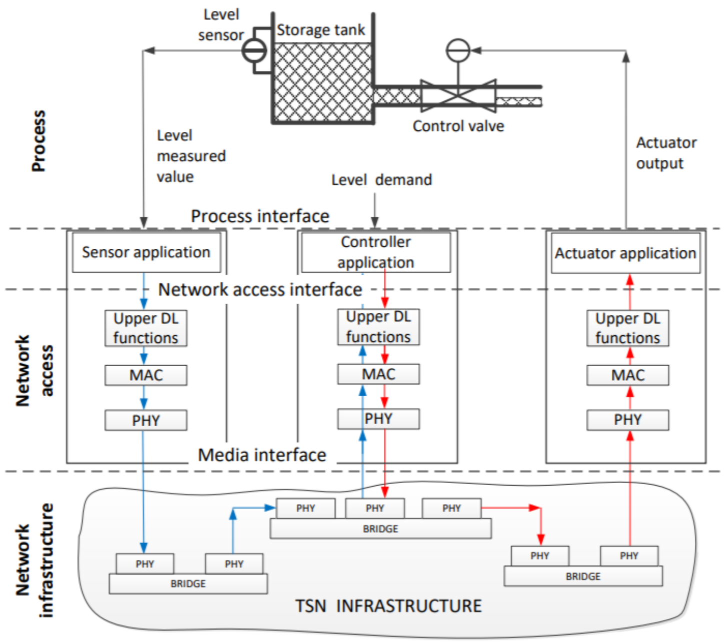
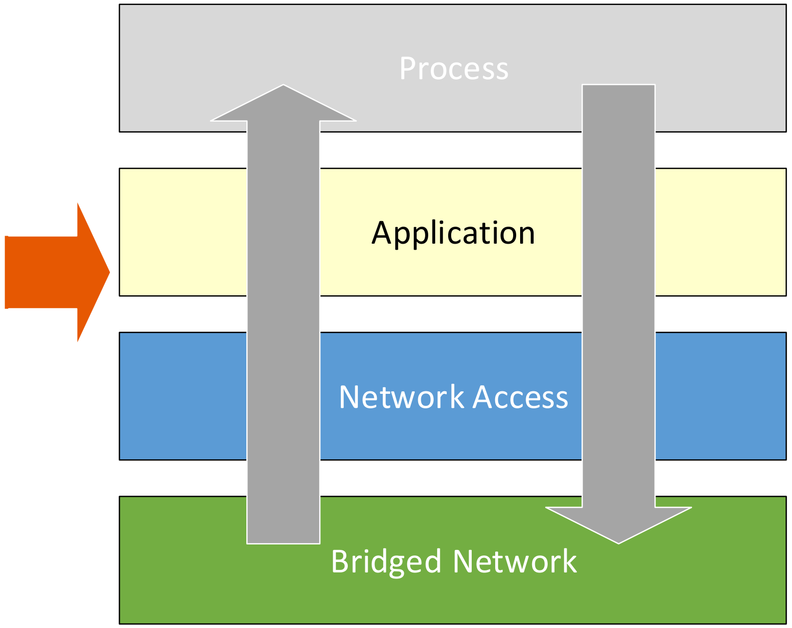


Figure 9 –Data flow in a control loop



This contribution covers one application timing model[1)2)] used in automation together with industrial communication.

Its roots a 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.

1) http://www.ieee802.org/1/files/public/docs2019/60802-industrial-use-cases-0918-v13.pdf
2) IEC/IEEE 60802 Draft D1.1 – Figure 9

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 lead to the implementation of so called process images[1)], which where in the beginning only a few bytes in size.

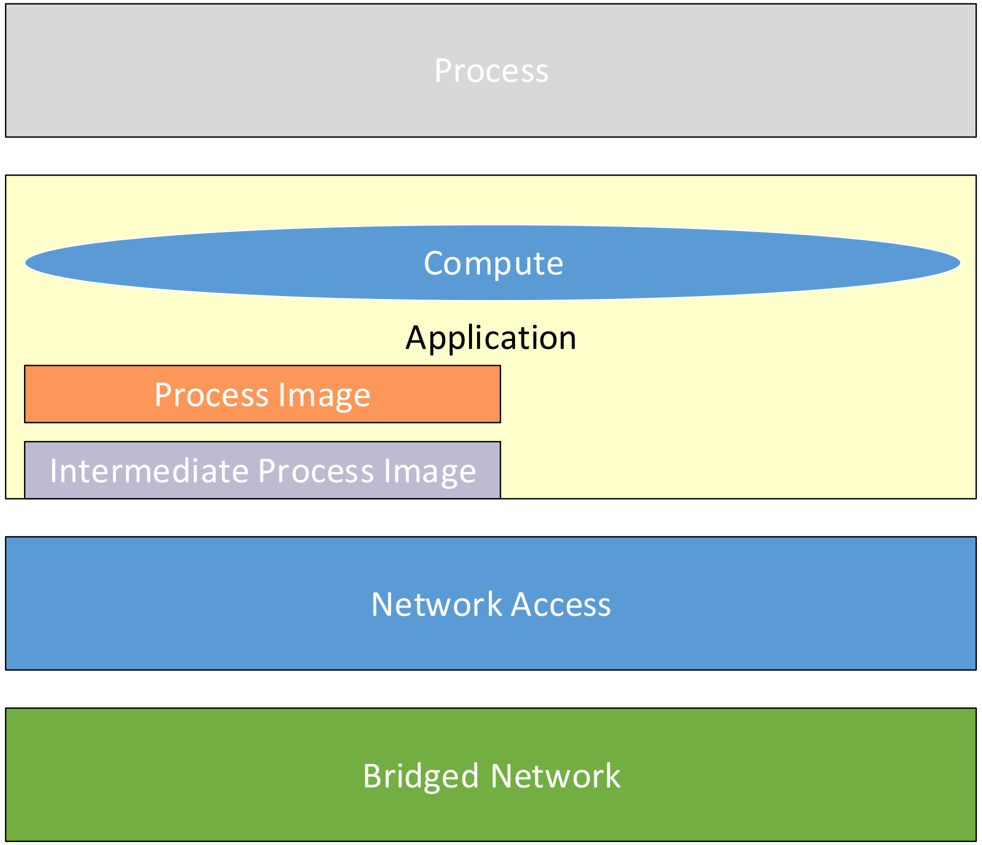
Basic timing model – fetching inputs, writing outputs, compute, repeat

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!

1) Local storage, like a cache, of all data which is cyclic exchanged between the connected applications.

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 25µs/31,25µs up to 1s.

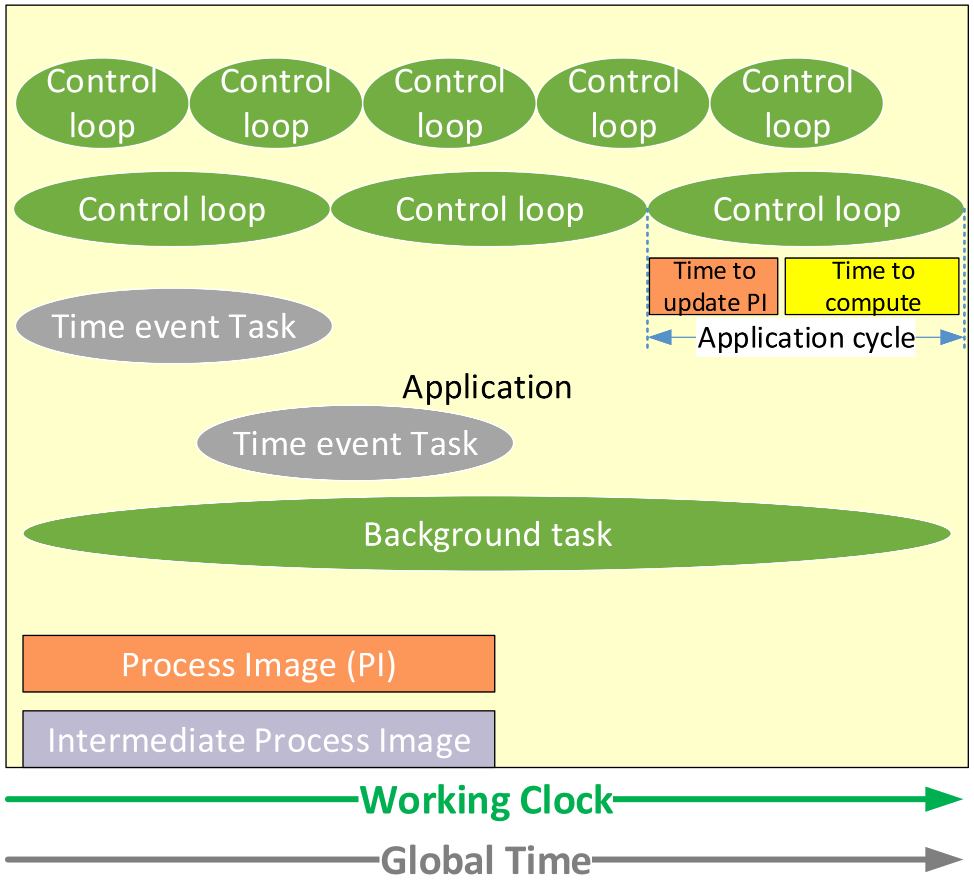
Thus, the update of the Process Image and the Network Access interact to support the requirements for timeliness from the applications.

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

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

1) Intermediate Process Image is introduced to show how the process image is kept stable while the cyclic communication is running.

Application - Compute



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

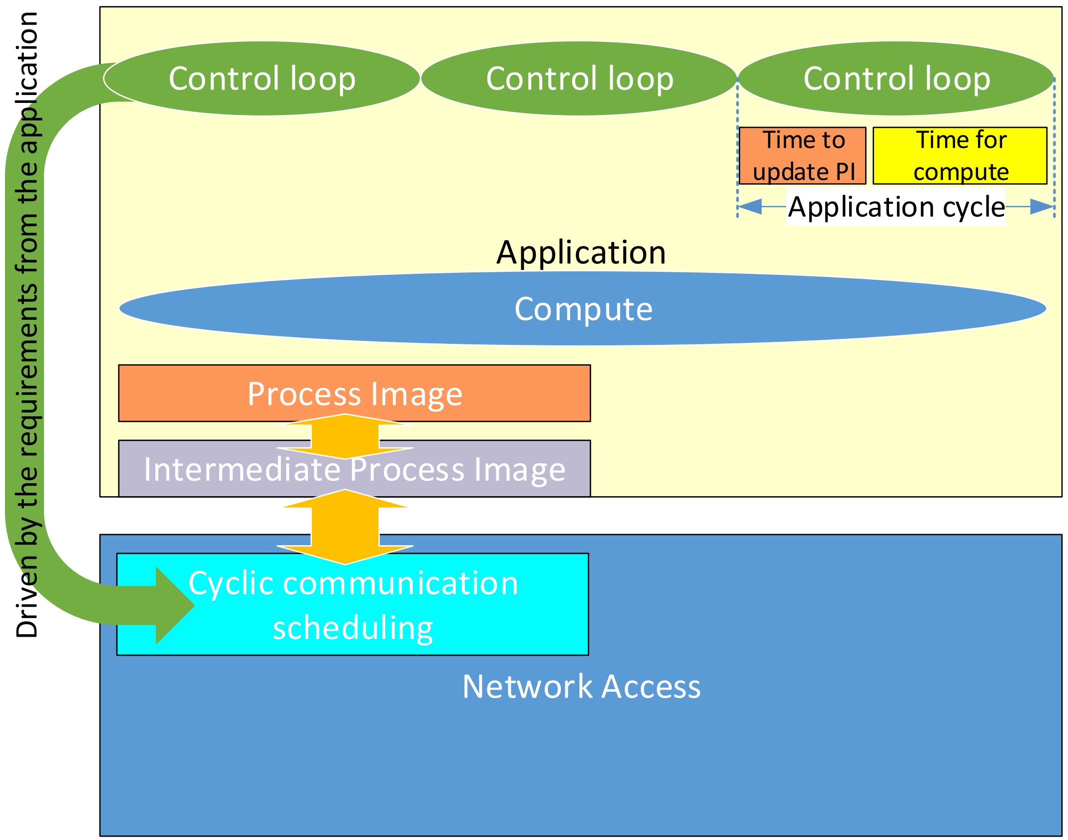
Time event tasks by Global Time (e.g. every noon do something), even if global time is locally managed in the PLC.

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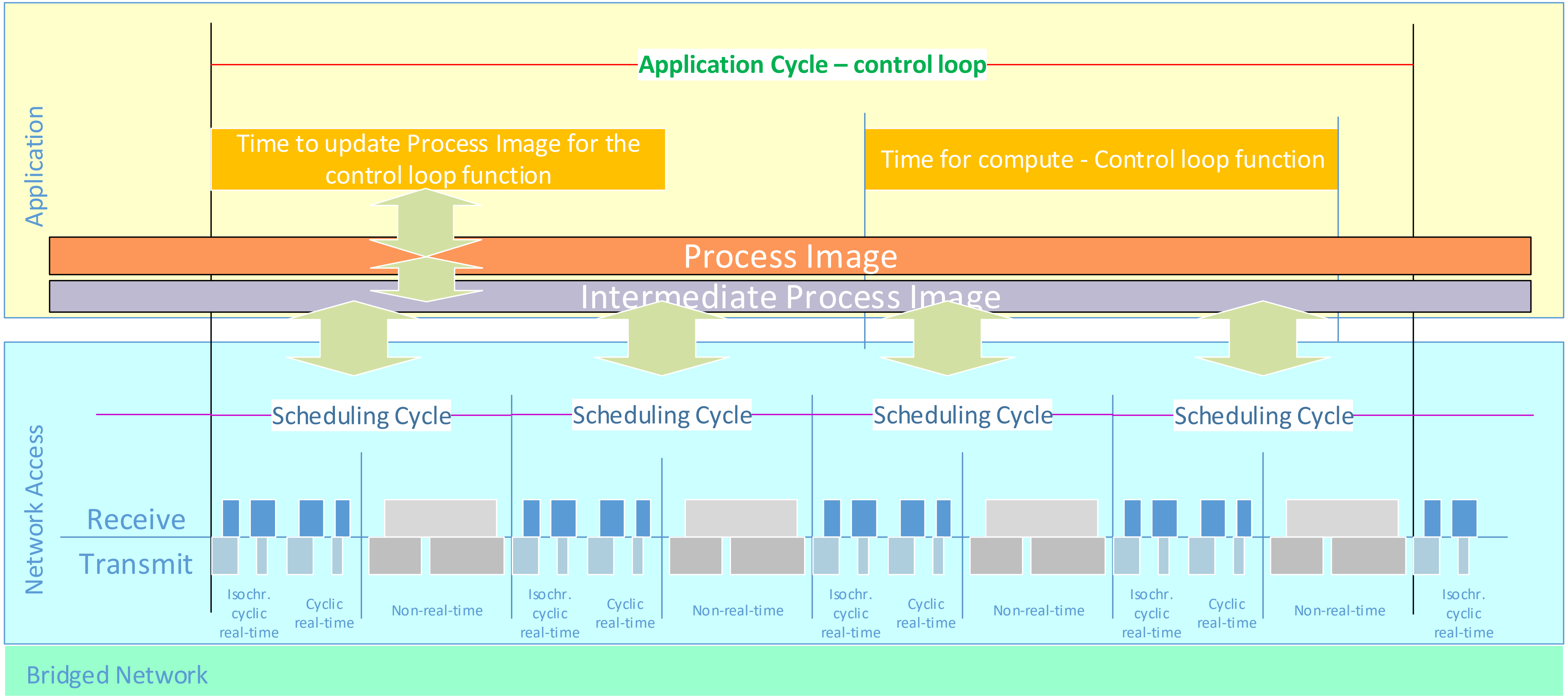
All the different requirements of the installed applications, including the background task, are used to create a scheduling for the streams used to update the Process Image.

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

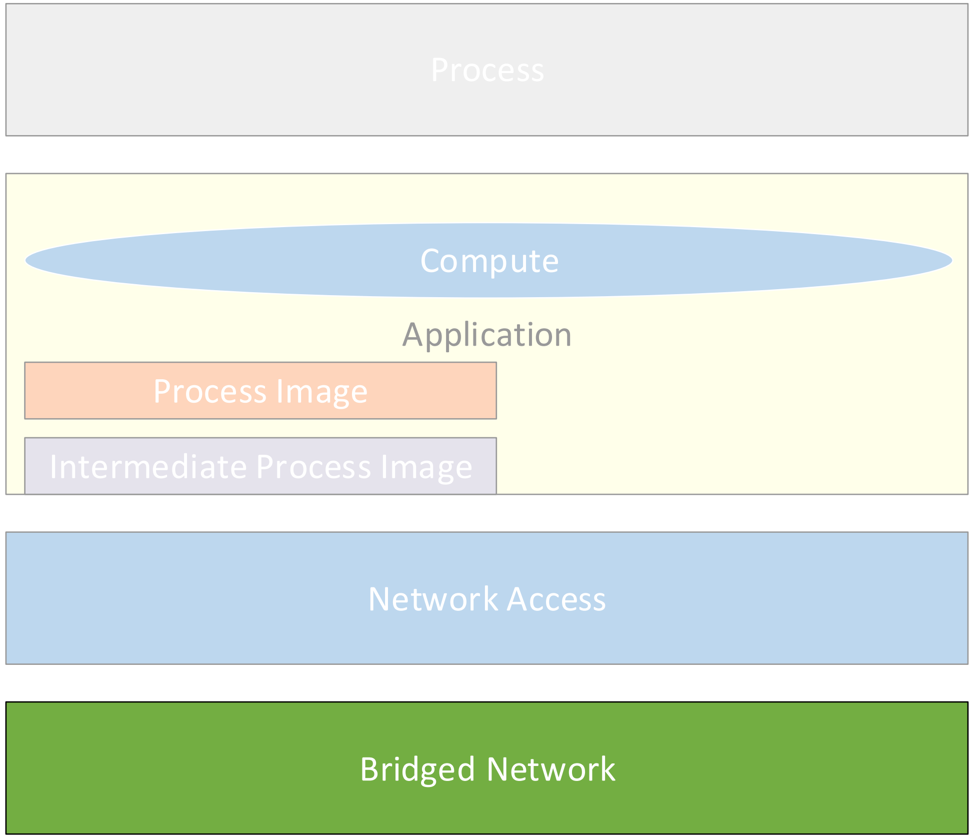
The cyclic communication scheduling includes the resource protection of the egress ports.

Example[1)] for cyclic communication scheduling



1) Actions for coherence and consistence are done in the background and not shown in this example

Bridged network



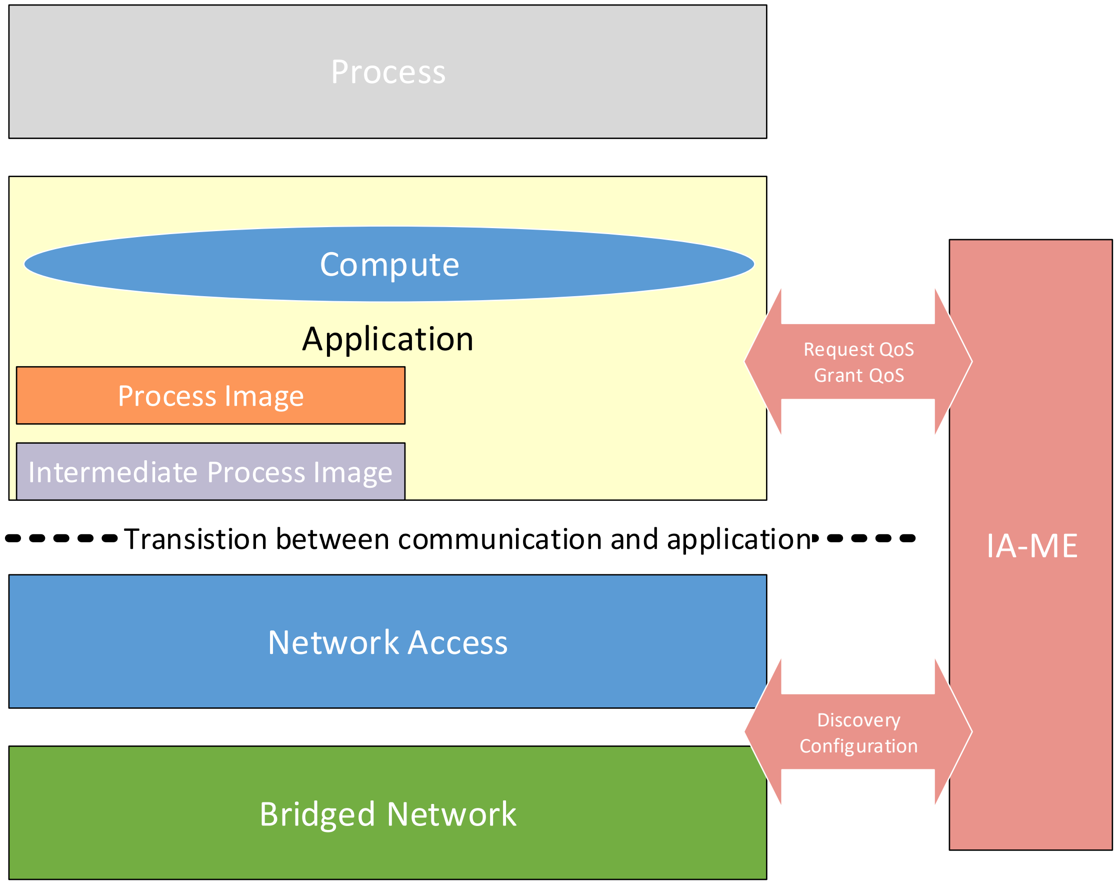
The bridged network provides

- Support of synchronization with an accuracy of |1µs|
- Support of zero congestion loss
- Support of bounded latency
- Support for seamless redundancy
- Fitting bandwidth
- …

summarized as “requested QoS for applications”.

The application is decoupled 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 scheduling the network access of the end stations.

IA-ME function, either offline and/or online, translates the application requirements into fitting configuration for network access and bridged network.

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

Questions?