Satisfying Real-Time Requirements of Multicore Software on ARINC 653: The Issue of Undocumented Hardware

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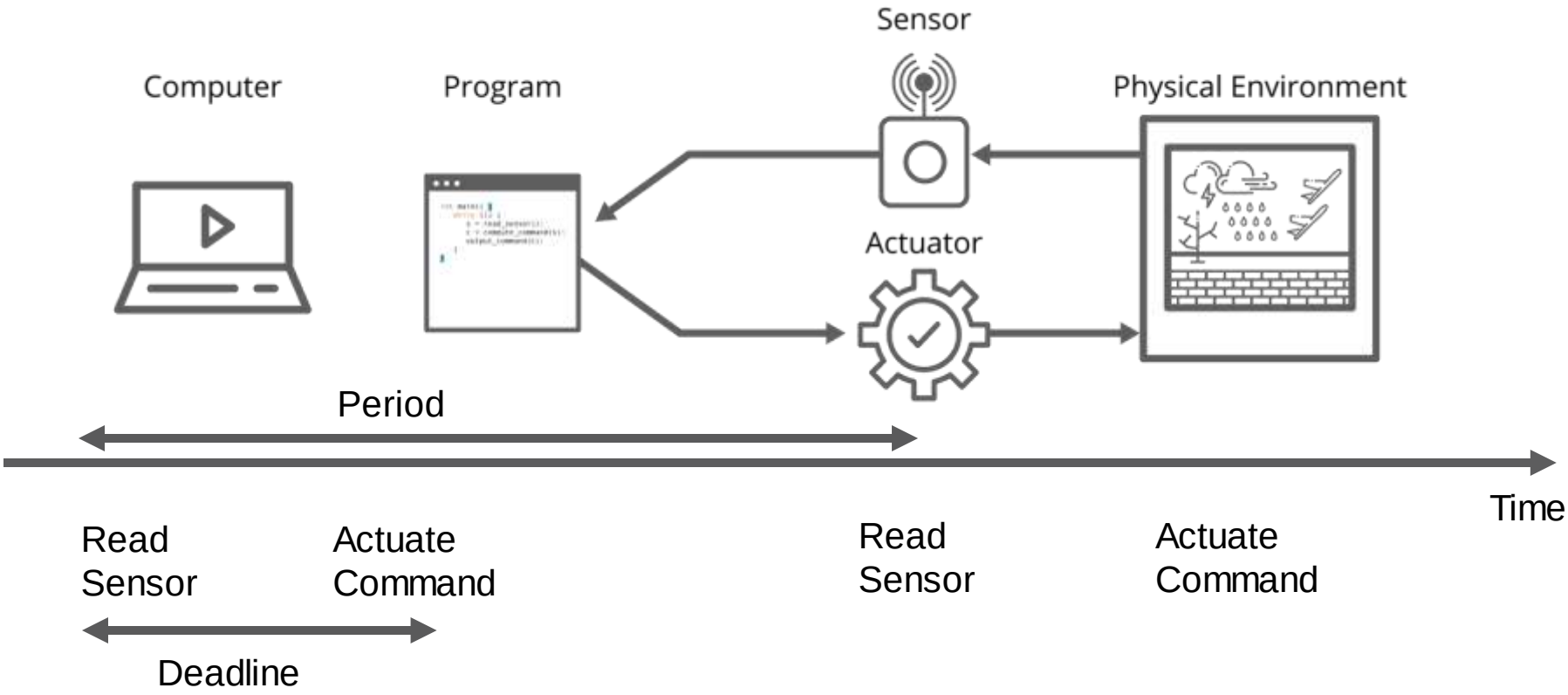
Single-core real-time systems



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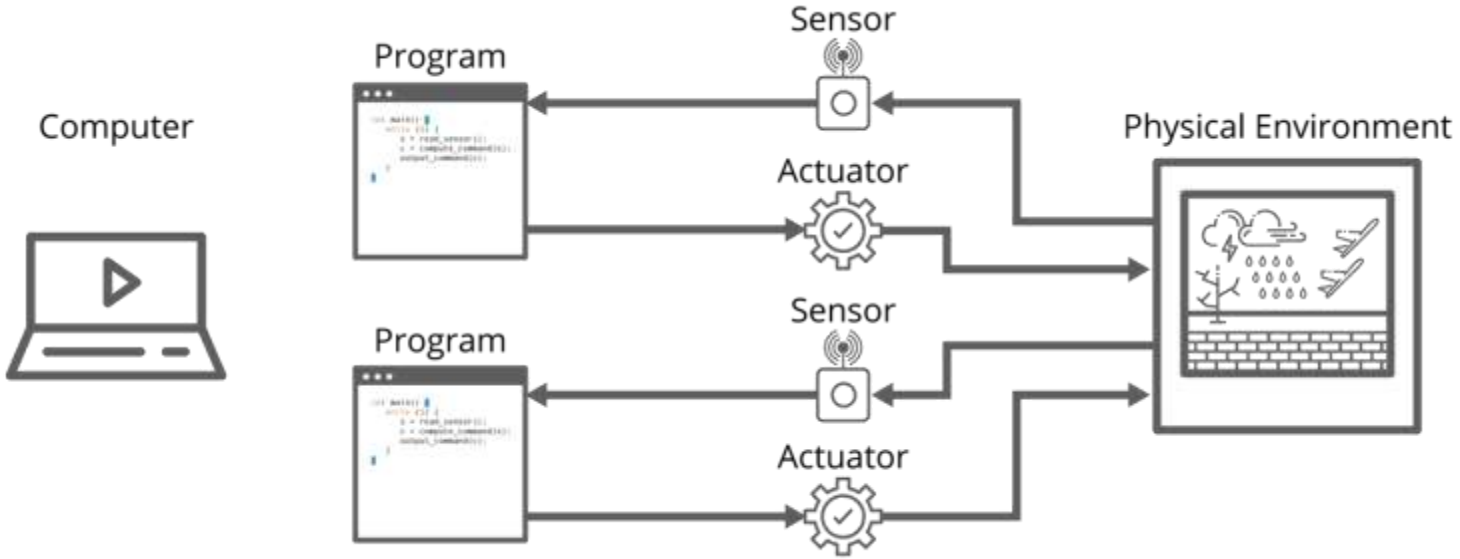

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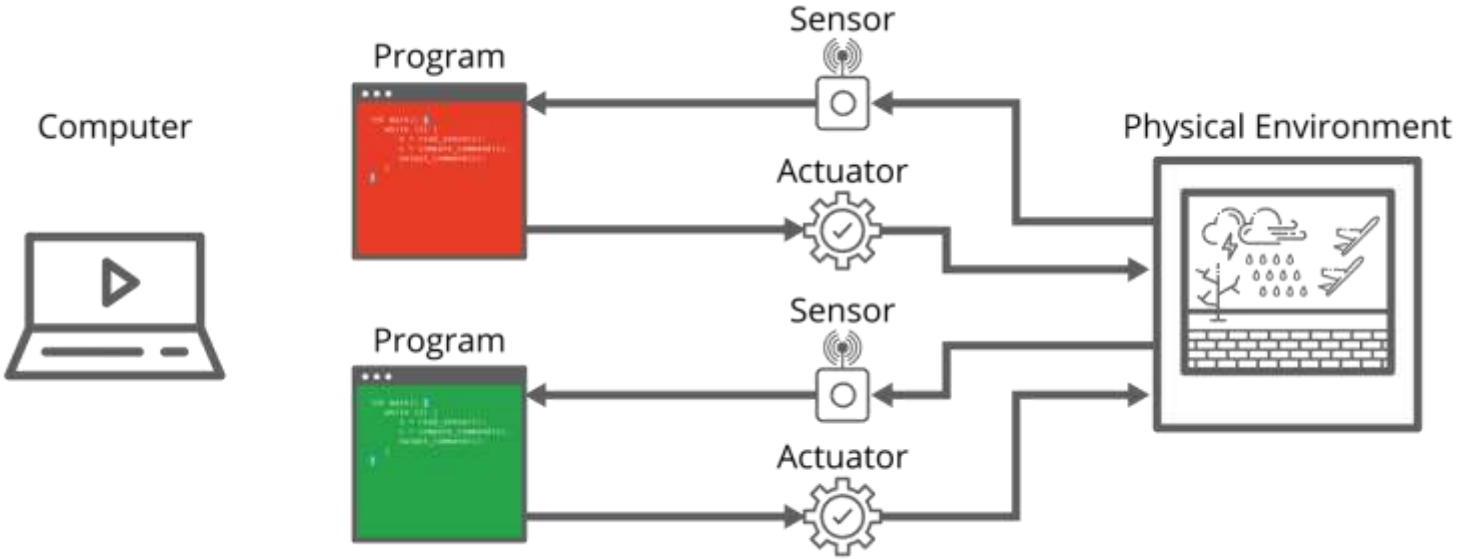
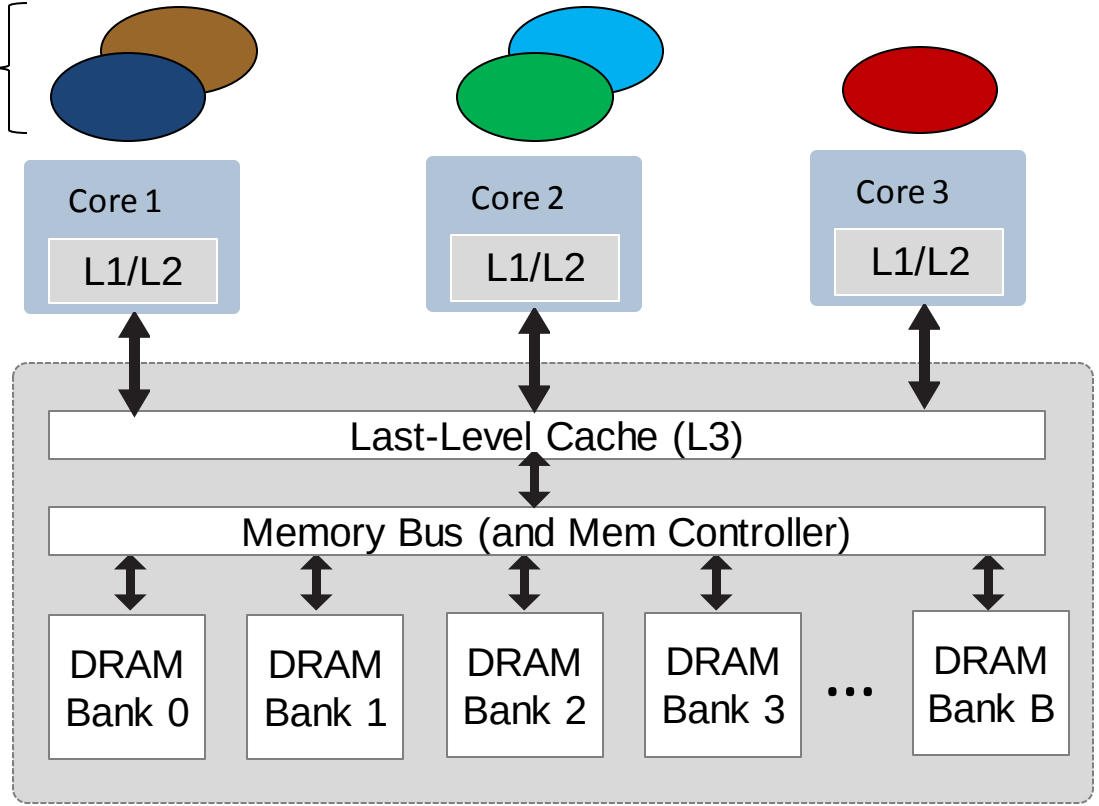


Multicore real-time systems

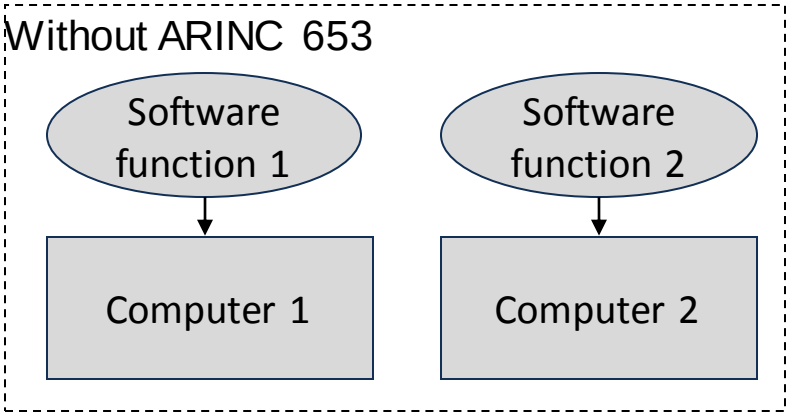
Issues

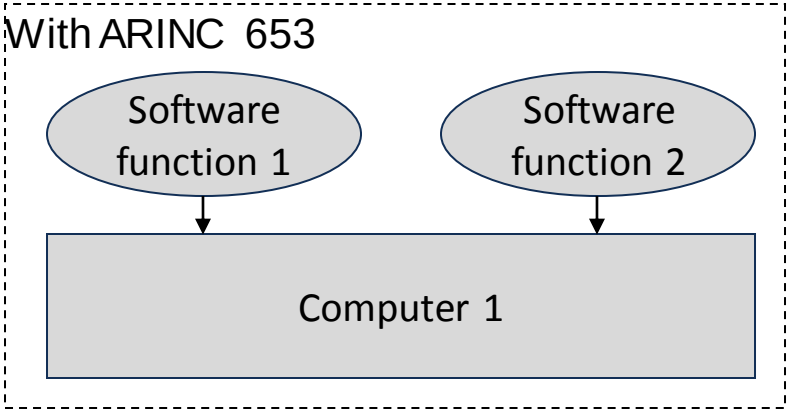
- Shared hardware resources impact timing.
- 103 times slowdown has been observed [Yun15].
- Most current methods cannot deal with undocumented resources.
- Even when resources are documented, current methods can only analyze/manage a small set of them.
- The problem is getting worse:
  * Slowdown increasing
  * More undocumented h/w



ARINC 653

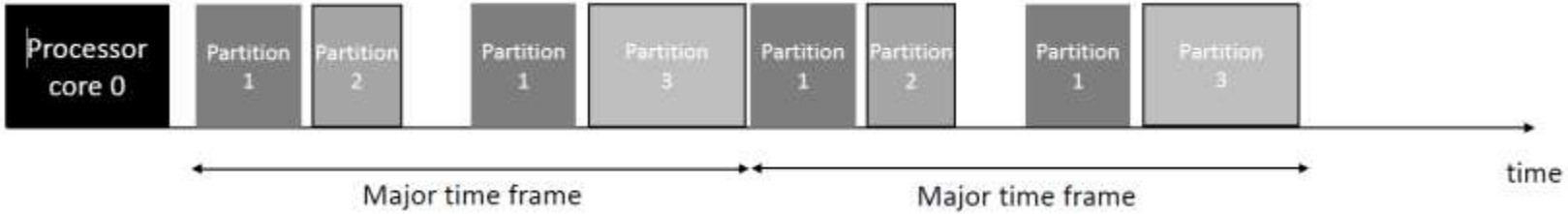
- Standard that facilitates integration of many software subsystems (called partitions) on a single computer





ARINC 653

- Standard that facilitates integration of many software subsystems (called partitions) on a single computer
- ARINC 653 uses a time-triggered scheduler to supply processing time to partitions.
- ARINC 653 initially only supported single-core systems



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This standard includes support for the ARINC 653 services to be utilized with a core module that contains a single or multiple processor cores. With multiple processor cores, additional scheduling paradigms are feasible on a core module:

- Multiple processes within a partition scheduled to execute concurrently on different processor cores.
- Multiple partitions scheduled to execute concurrently on different processor cores.

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- Multiple partitions scheduled to execute concurrently on different processor cores.

In the rest of this talk, we will assume this paradigm.

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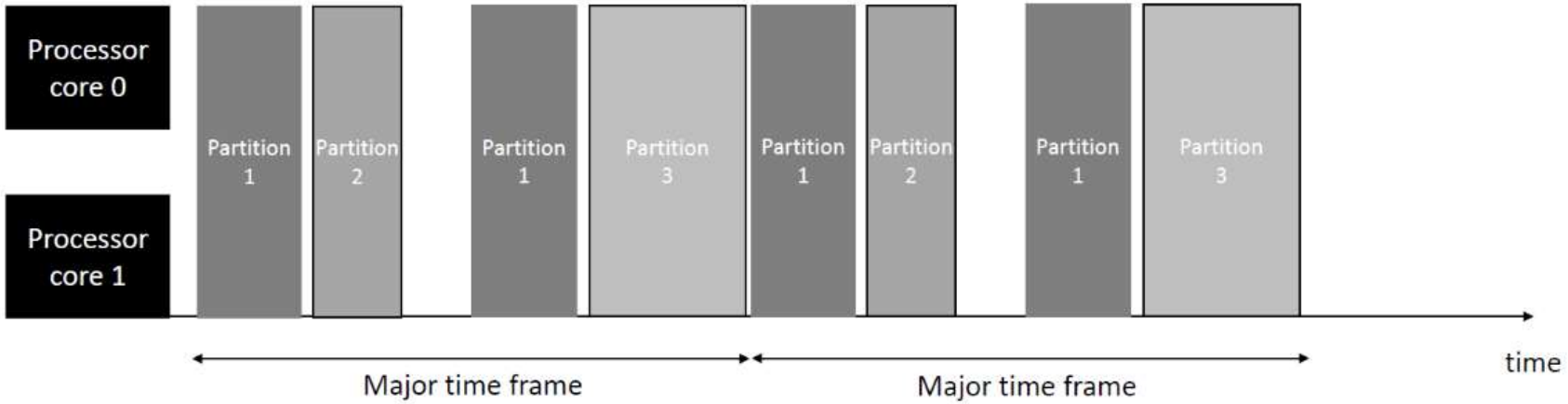

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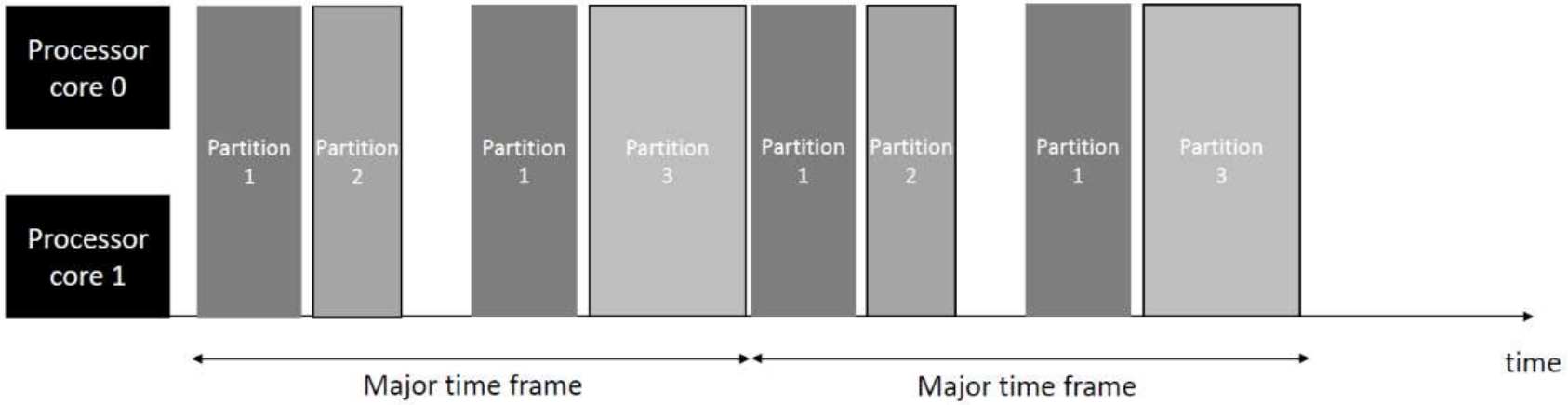

- How do we analyze real-time software executing over ARINC 653 on multicore processor with undocumented hardware?

Previous work

This Paper Compared to State-Of-The-Art

Can analyze ARINC 653	Yes	[5,6,7]	This paper
	No		[8]
		No	Yes
		Can analyze undocumented hardware	

References

[5] Y.-H. Lee, D. Kim, M. Younis, and J. Zhou, “Scheduling tool and algorithm for integrated modular avionics systems,” DASC, 2000.

[6] A. Mok, D.-C. Tsou, and R. de Rooij, “The MSP.RTL real-time scheduler synthesis tool,” RTSS, 1996.

[7] N. C. Audsley and A. J. Wellings, “Analysing APEX applications,” RTSS, 1996.

[8] B. Andersson, H. Kim, D. de Niz, M. Klein, R. Rajkumar, and J. Lehoczky, “Schedulability Analysis of Tasks with Co-Runner-Dependent Execution Times,” TECS, 2018.

Previous work

In this paper, we adapt [8] for ARINC 653.

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[8] uses a model that describes the effect of sharing of hardware resources in the memory system without actually modelling the resources in the memory system.

$\Rightarrow$

allows analysis of software executing on undocumented hardware.

Main result in this paper

Theorem 1: If $\forall \tau_i \in \tau \quad \exists t \in [0, D_i]$ $reqlpARINC653(\tau, \Pi, PART, i, t) \leq sbf_I(\tau, \Pi, PART, i, t)$, then the system is schedulable.

This is a minor adaptation from previous work [8].

This is new in this paper.

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How much processing time is requested

How much processing time is supplied

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The ARINC 653 standard can be interpreted in different ways. This yields different bounds on supply of processing time.

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I allows you to specify which interpretation you want to use.

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For details: see paper.

Conclusion

It is possible to satisfy real-time requirements of multicore software on ARINC 653 and deal with the issue of undocumented multicore.