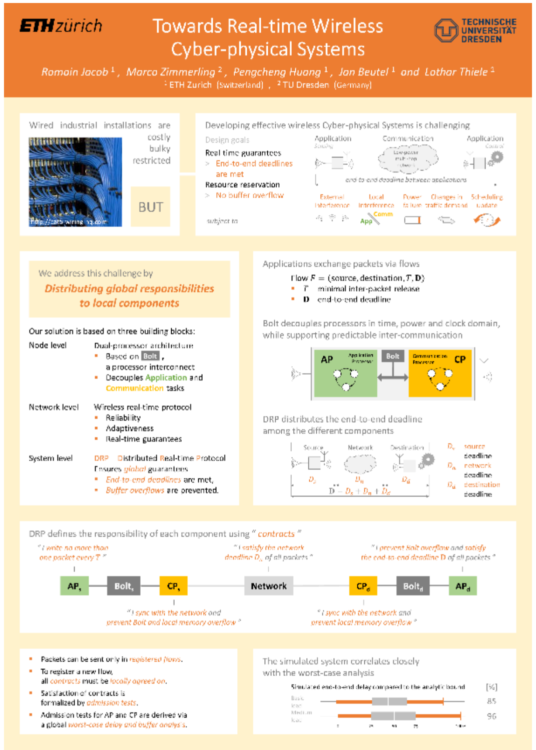
Towards Real-time Wireless Cyber-physical Systems



Romain Jacob Marco Zimmerling
Pengcheng Huang Jan Beutel
Lothar Thiele

ECRTS 16 – WiP Session
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200

Installation cost ($)
per meter of cable

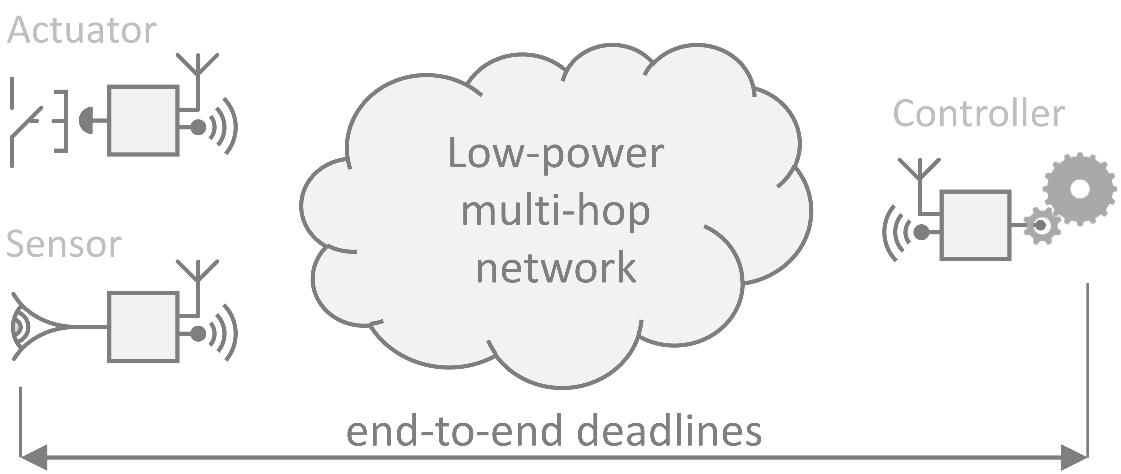
http://cat5-wiring-hq.com

Sensors
Actuators
Controllers

*Let’s try to
go wireless!*

Developing effective wireless Cyber-physical Systems is challenging

Design goals	Real-time guarantees	>	*End-to-end deadlines are met*
	Resource reservation	>	*No buffer overflow*



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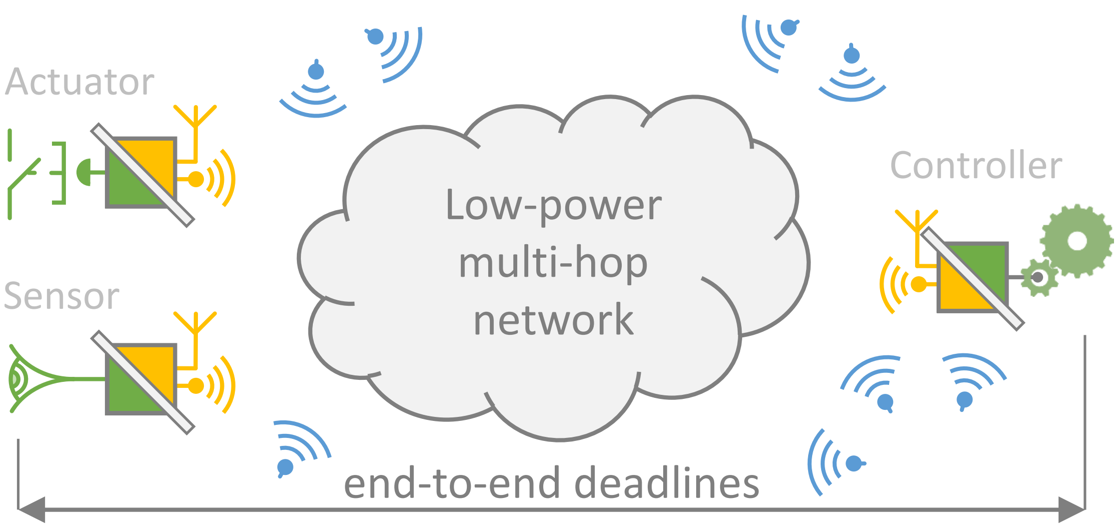
Require

Reliability



Subject to

External interference

Local interference

Developing effective wireless Cyber-physical Systems is challenging

Design goals

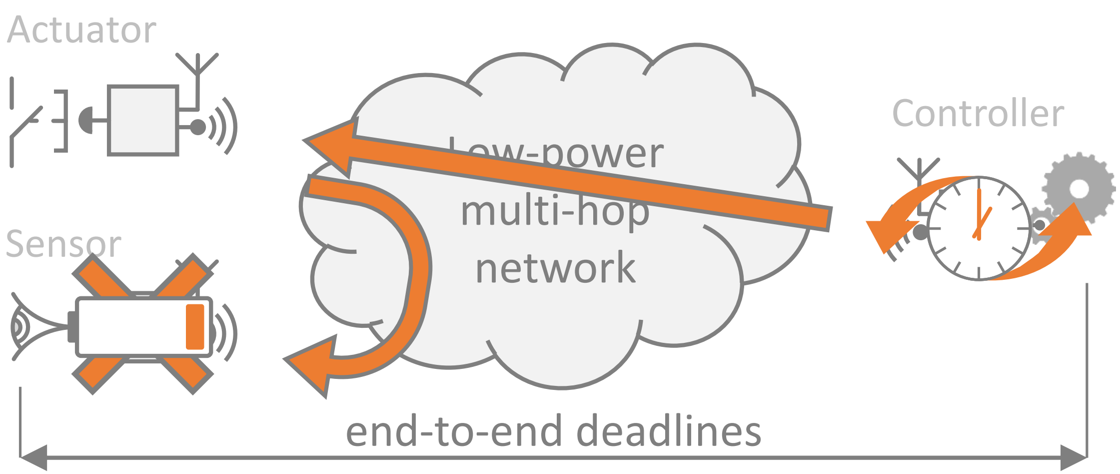
Real-time guarantees > *End-to-end deadlines are met*

Resource reservation > *No buffer overflow*

Require

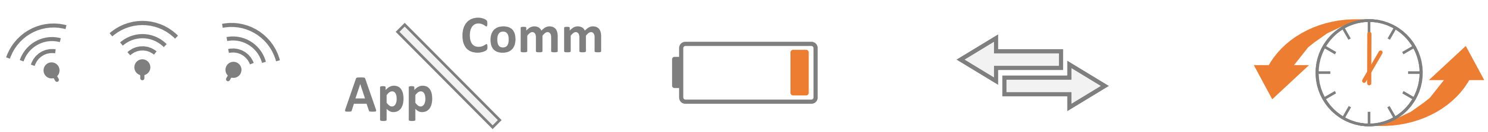
Reliability

Adaptiveness



Subject to

External interference | Local interference | Power failure | Changes in traffic demand | Scheduling update



There is hope for

Real-Time Wireless

Cyber-Physical Systems!

We tackle the wireless CPS challenge by combining…

Wireless real-time protocol	[1]	Reliable Adaptive Real-Time	Communication
Dual-processor architecture	[2]	Decouples	Application Communication
Distributed real-time protocol (DRP)		Ensures deadlines Prevents overflows	

[1] Zimmerling M. et al., *Adaptive Real-time Communication for Wireless Cyber-physical Systems* Tech. Rep., ETH Zurich, **2016**
[2] Sutton F. et al., *Bolt: A Stateful Processor Interconnect*, SenSys'15, **2015**

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We tackle the wireless CPS challenge by combining…

Wireless real-time protocol [1]

Reliable | Adaptive | Real-Time — Communication

Dual-processor architecture [2]

Decouples — Application | Communication

Distributed real-time protocol (DRP)

Ensures deadlines
Prevents overflows

Leveraging

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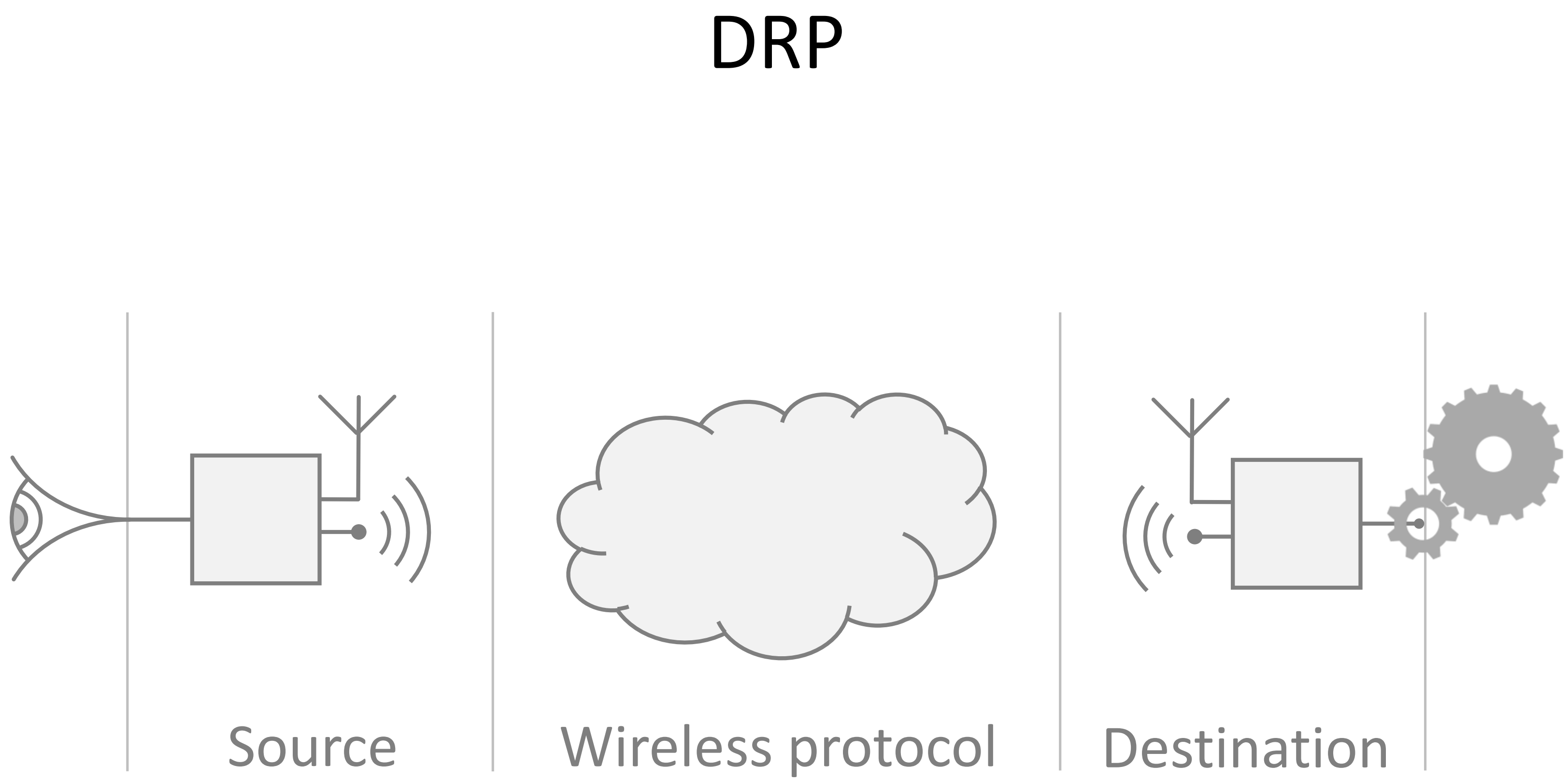
DRP is based on *contracts*, which distribute responsibilities between components



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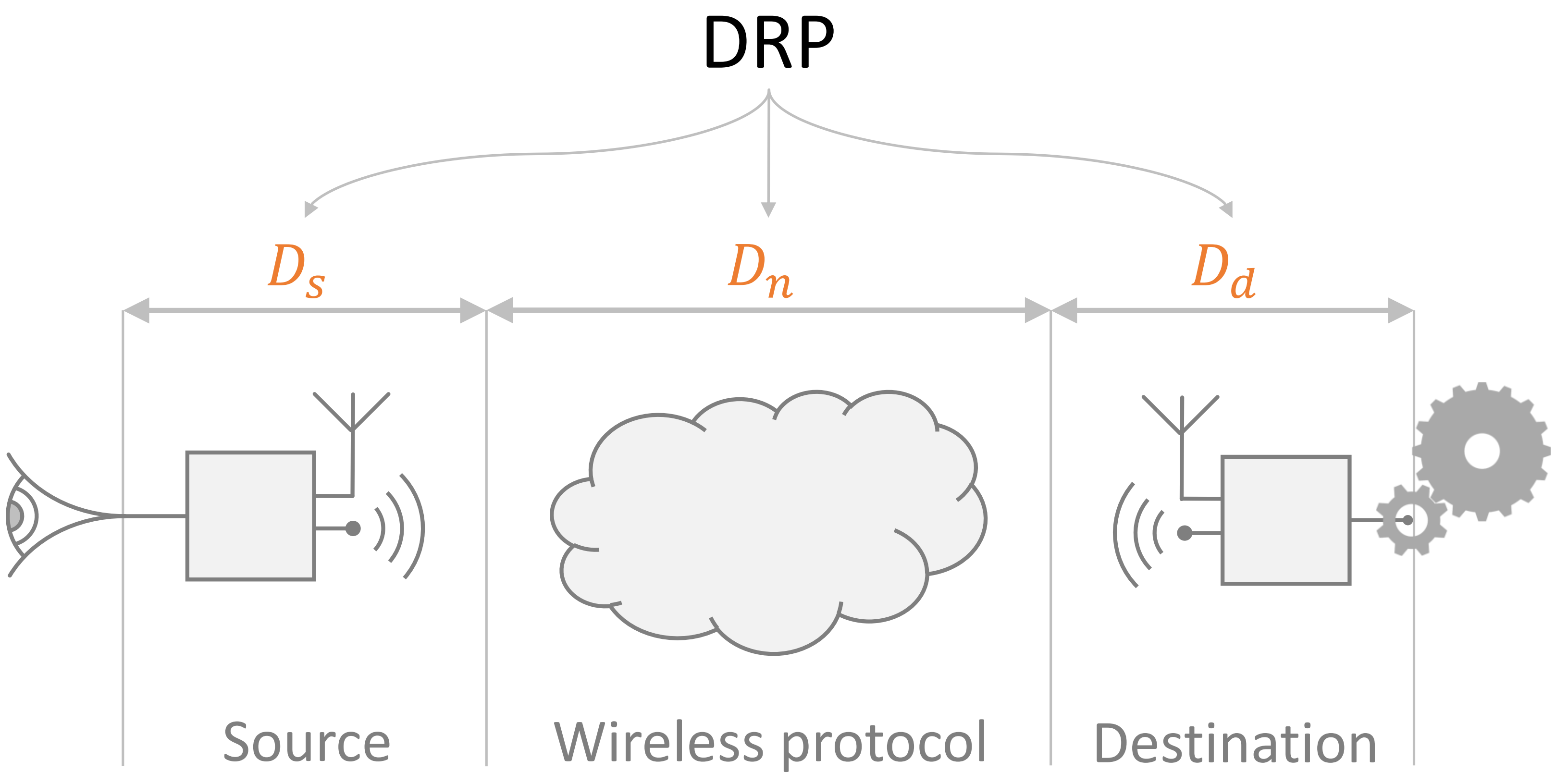

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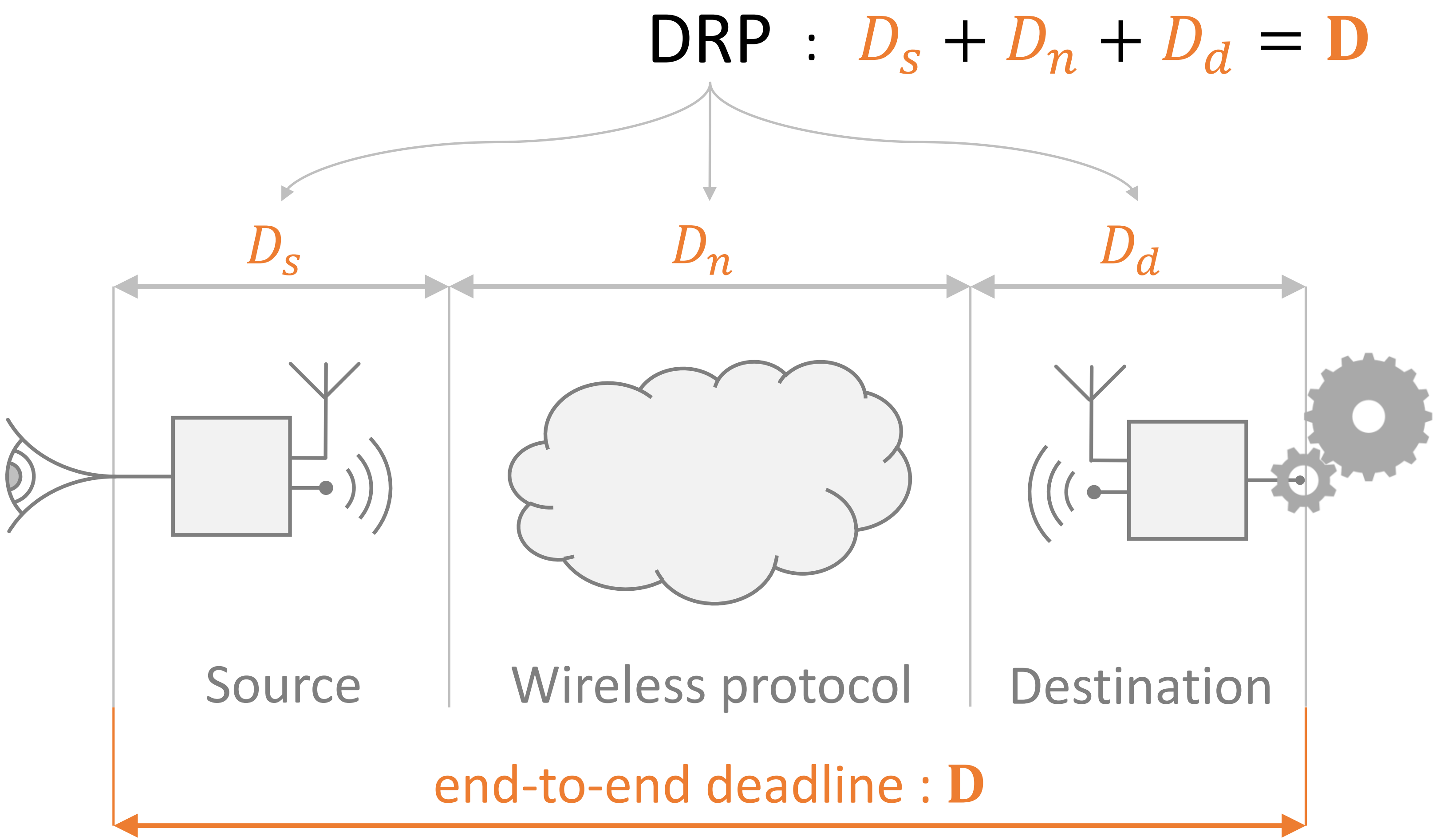


The challenging task is to *formalize* the contracts

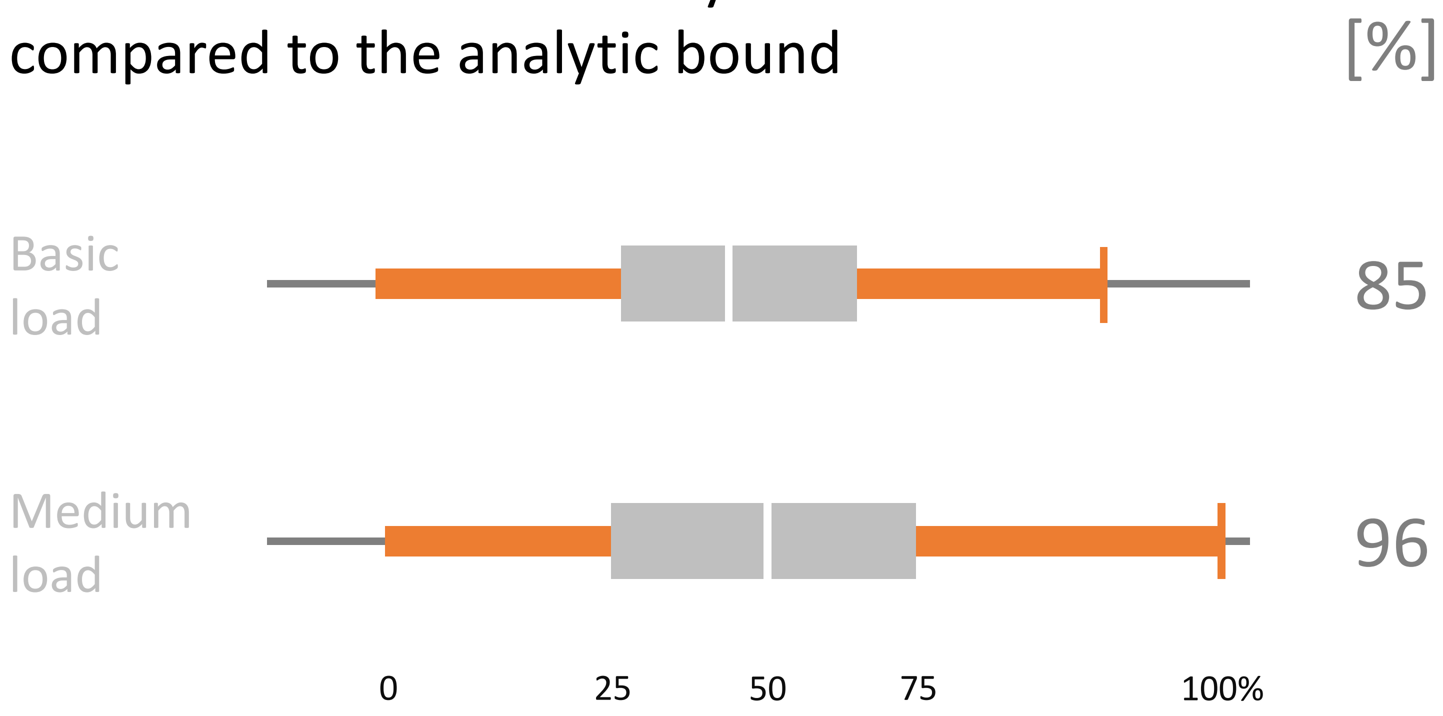
Given sporadic “ *read* ” and “ *write* ” operations
periodic wireless communication protocol

Requires to

- Define the local schedule constraints
- Perform a global worst-case analysis — *Delays*, *Buffers*
- Distribute the responsibilities

The simulated system correlates closely with the analysis

Simulated end-to-end delay
compared to the analytic bound



There is still work to be done before convincing both industry and academia

Physical implementation of the protocol	Extensive testing on Flocklab *public WSN testbed*
Dependability evaluation and optimization	Probability of failure Retransmission scheme
Reaching meaningful performances	Very low rate — few *bps* Very small deadlines — from 10*ms* to 0.5*s*

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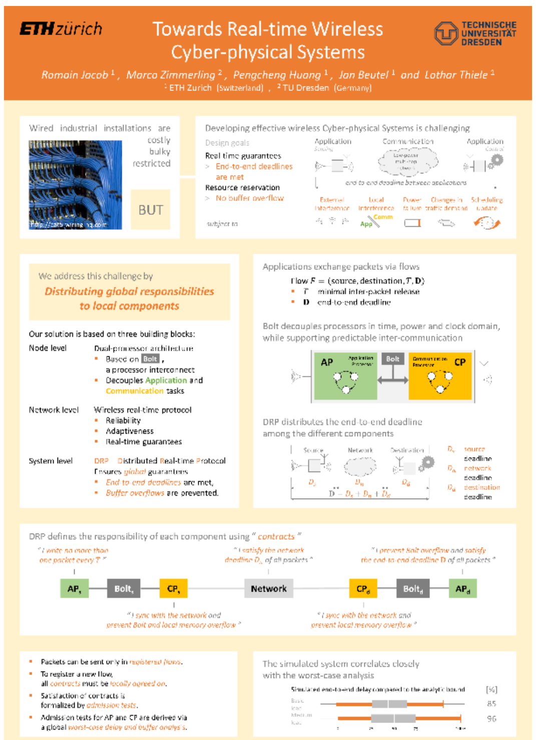

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