Towards Real-time Wireless Cyber-physical Systems

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Wired industrial installations are costly bulky restricted

BUT

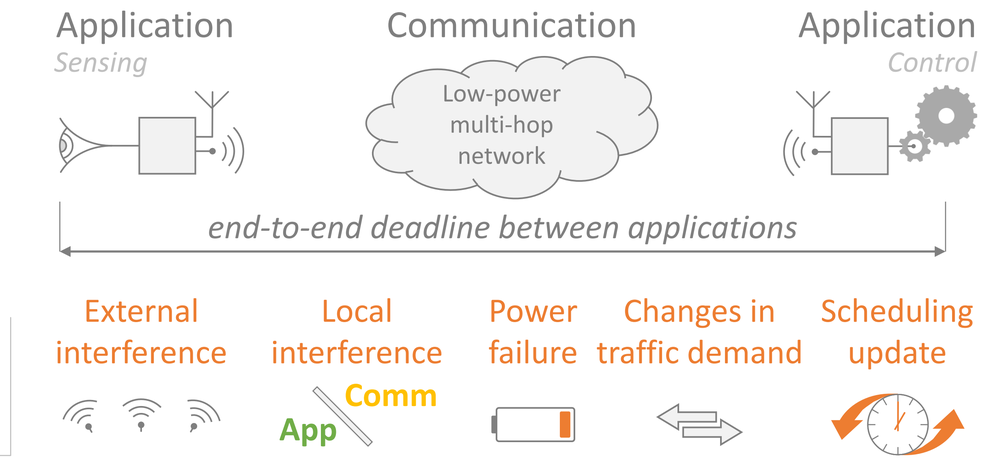
Developing effective wireless Cyber-physical Systems is challenging

Design goals

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

Resource reservation
> No buffer overflow

subject to



We address this challenge by

Distributing global responsibilities to local components

Our solution is based on three building blocks:

Node level — Dual-processor architecture
- Based on **Bolt**, a processor interconnect
- Decouples **Application** and **Communication** tasks

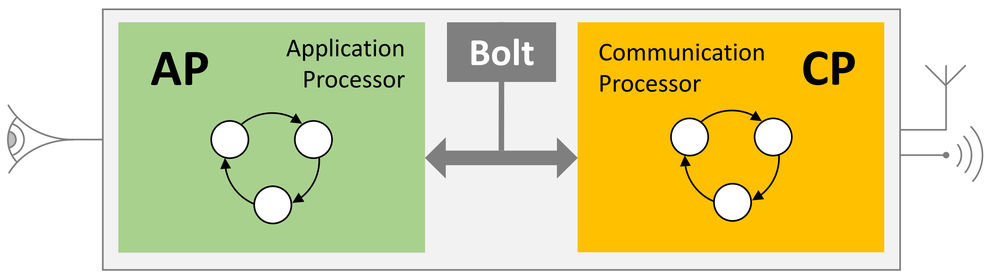
Network level — Wireless real-time protocol
- Reliability
- Adaptiveness
- Real-time guarantees

System level — DRP Distributed Real-time Protocol
Ensures *global* guarantees
- *End-to-end deadlines* are met,
- *Buffer overflows* are prevented.

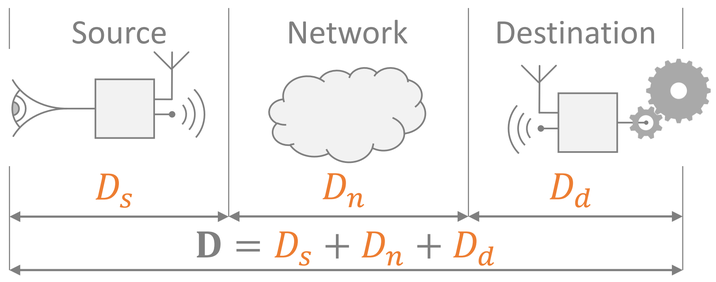
Applications exchange packets via flows

Flow $F = (\text{source}, \text{destination}, T, \mathbf{D})$
- T minimal inter-packet release
- $\mathbf{D}$ end-to-end deadline

Bolt decouples processors in time, power and clock domain, while supporting predictable inter-communication

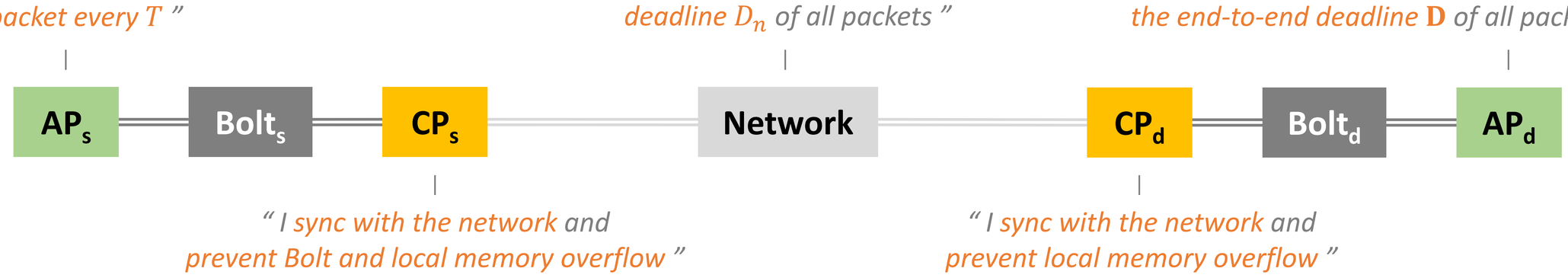


DRP distributes the end-to-end deadline among the different components



D_s source deadline
D_n network deadline
D_d destination deadline

DRP defines the responsibility of each component using " *contracts* "



- Packets can be sent only in *registered flows*.
- To register a new flow, all *contracts* must be *locally agreed on*.
- Satisfaction of contracts is formalized by *admission tests*.
- Admission tests for AP and CP are derived via a global *worst-case delay and buffer analysis*.

The simulated system correlates closely with the worst-case analysis