Towards Real-time Wireless Cyber-physical Systems

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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.

Developing effective wireless Cyber-physical Systems is challenging

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

Applications exchange packets via flows

Flow $F = (s, d, T, D)$
- $T$: minimal inter-packet release
- $D$: 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

$D = D_s + D_n + D_d$

We address this challenge by

**Distributing global responsibilities to local components**

- 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.

- Subject to

\begin{align*}
\text{DRP defines the responsibility of each component using "contracts"} \\
\text{"I write no more than one packet every } T\text{"} & \quad \text{"I satisfy the network deadline } D_n \text{ of all packets"} & \quad \text{"I prevent Bolt overflow and satisfy the end-to-end deadline } D \text{ of all packets"} \\
\text{"I sync with the network and prevent Bolt and local memory overflow"} & \quad \text{"I sync with the network and prevent local memory overflow"} \\
\end{align*}