Mixed Criticality Scheduling Applied to JPEG2000 Video Streaming over Wireless Multimedia Sensor Networks

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Outline

- Wireless Multimedia Sensor Networks (WMSNs)
  - Introduction
  - Applications
- Objectives of this work
- Mixed-criticality in context of WMSNs
- Testbed
- Experimental results
- Conclusion and Future works

Wireless Multimedia Sensor Networks

- Networks of wireless devices capable of sensing
  - Multimedia content (video, audio, still images)
  - Scalar sensor data (temperature, humidity …)

- With integrated components of
  - CMOS cameras
  - Microphones
  - Low-cost small scale imaging sensors

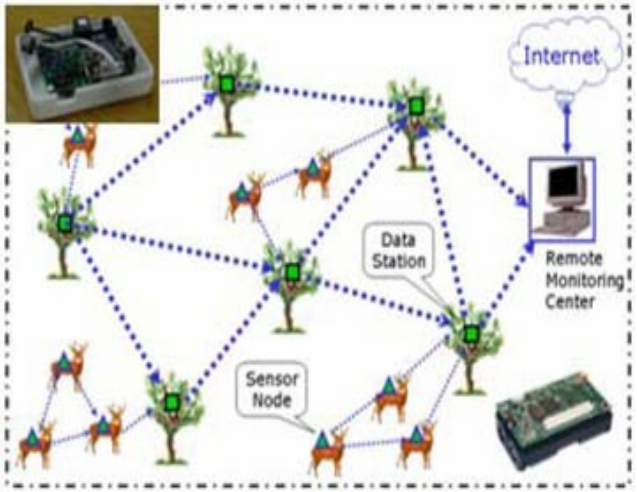
- Difference with Wireless Sensor Networks
  - most of WSNs measure scalar physical phenomena like temp., pressure, humidity and
  - They require low bandwidth and are delay tolerant

Applications of WMSNs

- multimedia surveillance networks
- Road traffic monitoring
- Environmental monitoring
- Target tracking
- etc …

Constraints in WMSNs

- limited computational power
- reduced memory
- Narrow bandwidth
- limited energy support
- etc …



So, Image and video transmission over such networks is still an important challenge to address

Objective of this work

To address these issues, we apply

Mixed-criticality Paradigm

for efficient transmission of multi-layer JPEG2000 based image and video over such constrained networks.

Mixed-criticality in the context of WMSNs

- In wireless networks, wireless channel capacity varies due to:

  e.g, interference from neighboring devices

- Hence, when channel quality is degraded,

  Why do we need to transmit all information (both critical and non-critical)?

Don’t over chunk the Baby!!!

- JPEG2000 provides seamless progressive transmission by resolution and quality

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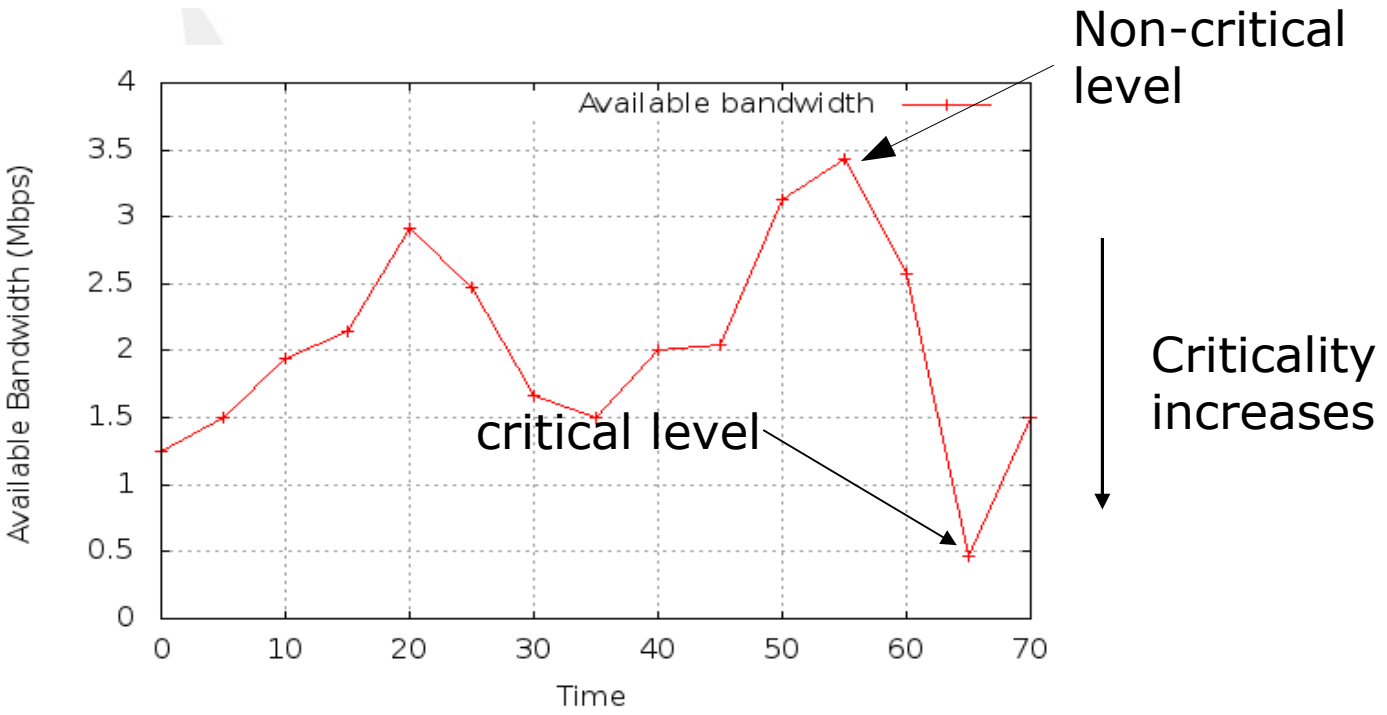
- The MC nature of the wireless system arises from the fact that
  - Under high availability of bandwidth
    - transmit all information(all layers and resolution)
  - However, when the bandwidth is low
    - transmit only critical information



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MC Principles

- We have a non-preemptive wireless communication channel
  - L criticality levels defined by bandwidth thresholds
  - Transmission of periodic frames

- B(l) is the available bandwidth at level l
  - $B(l+1) \leq B(l)\ \forall\ l \in [1, L]$
  - The transmission time increases with criticality

$$C_i(l) = N_i / B(l)$$

Worst Case end-to-end Response Time

Why does it matter?

- End-to-End response time impacts **freshness and liveliness**
- classical QoS approaches tends to
  - reduced QoE ... Less visual comfort when bandwidth is low
- Our goal with MC: continuity in visualization with lower image quality when bandwidth is low

Two classical approaches to deal with WCERT
- Trajectory
- Holistic

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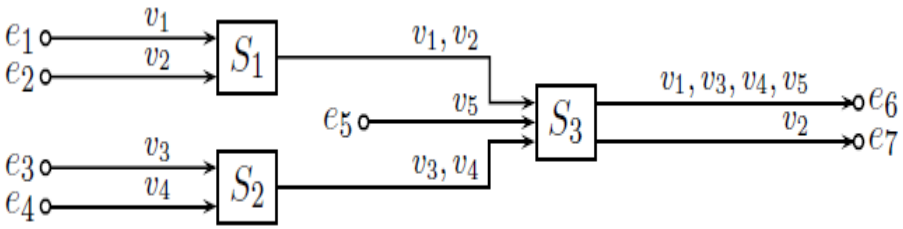
We apply the trajectory approach,

- It considers scheduling produced by all visited nodes along the path of a flow
- It has two components
  - max delay due to non-preemption
  - latest start time in the last node

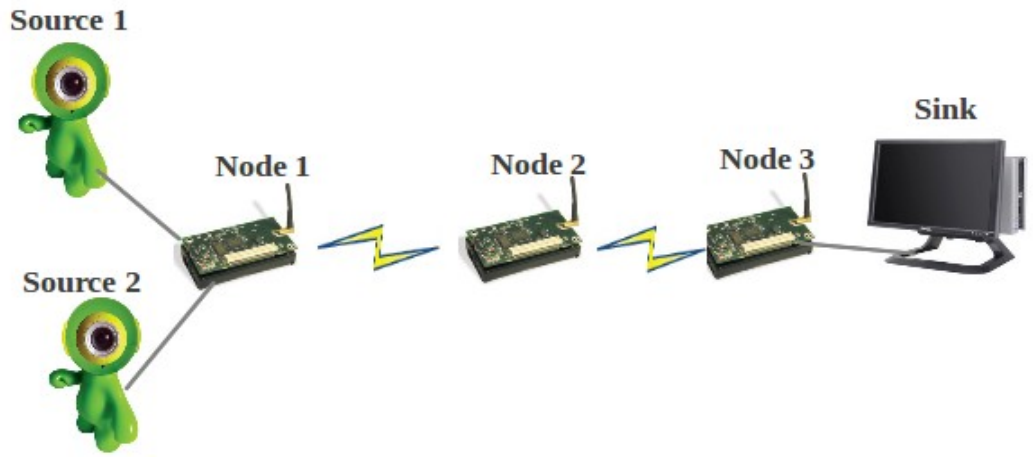


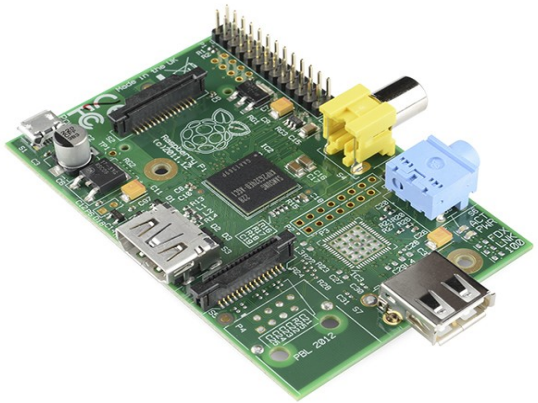
- This approach provides a good upper bound on the WCERT in deterministic networks (e.g. LAN)
- However, in the context of wireless networks, the estimated available bandwidth always considered as the minimum available bandwidth … which can be pessimistic

The π-sense testbed

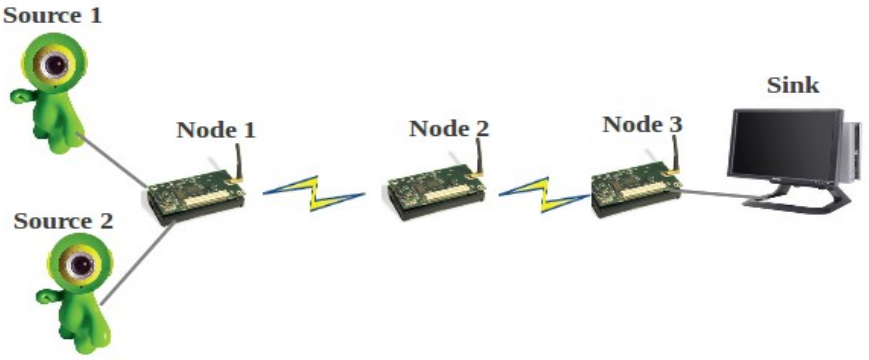
Components

- Raspberry pi
- WIFI dongle
- Babel
- JPEG2000
- WBest

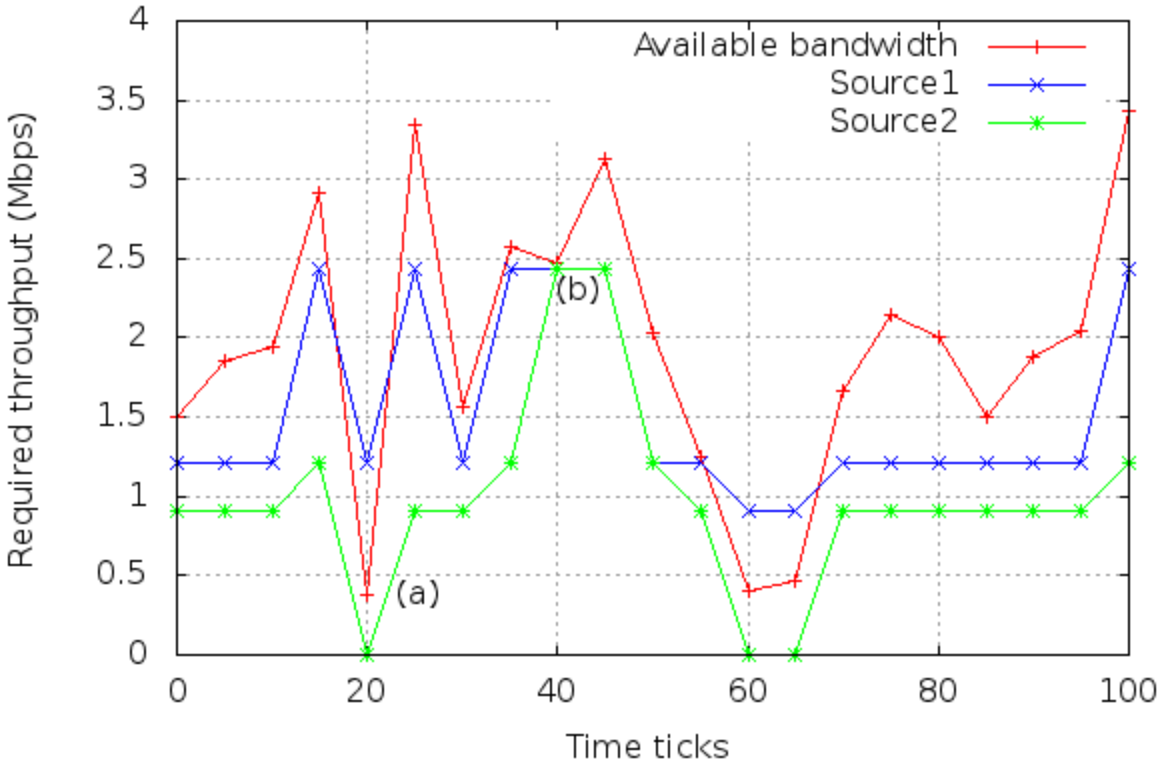




MC-wireless



1. Fixed priority for the sources
2. Criticality levels that corresponds to available bandwidth values



Criticality Levels

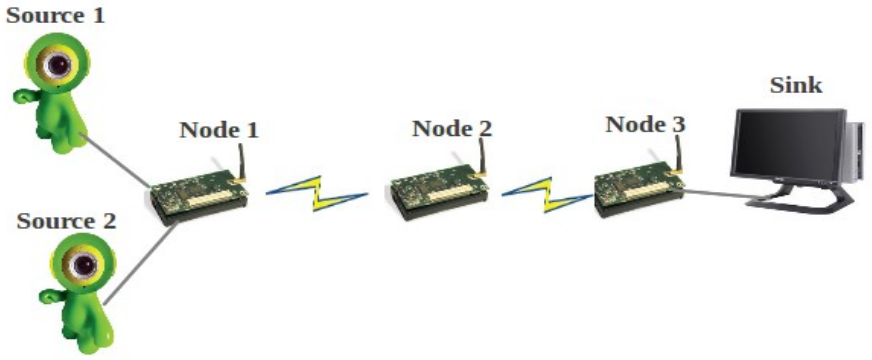
Level 1

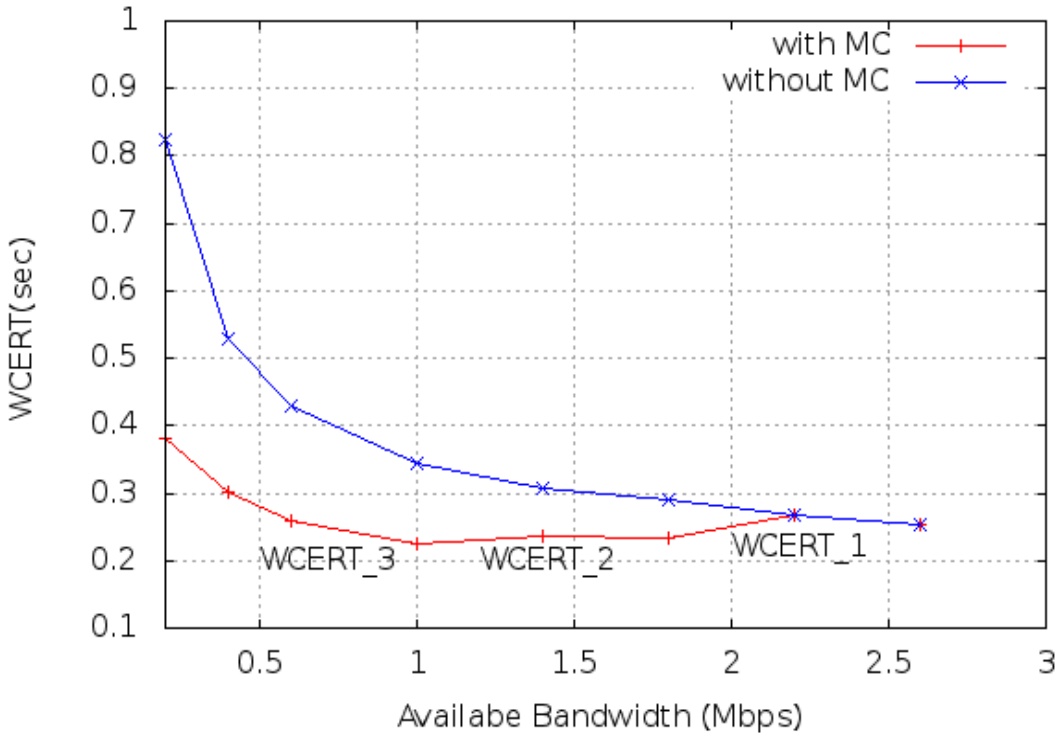
Level 2

Level 3

Results

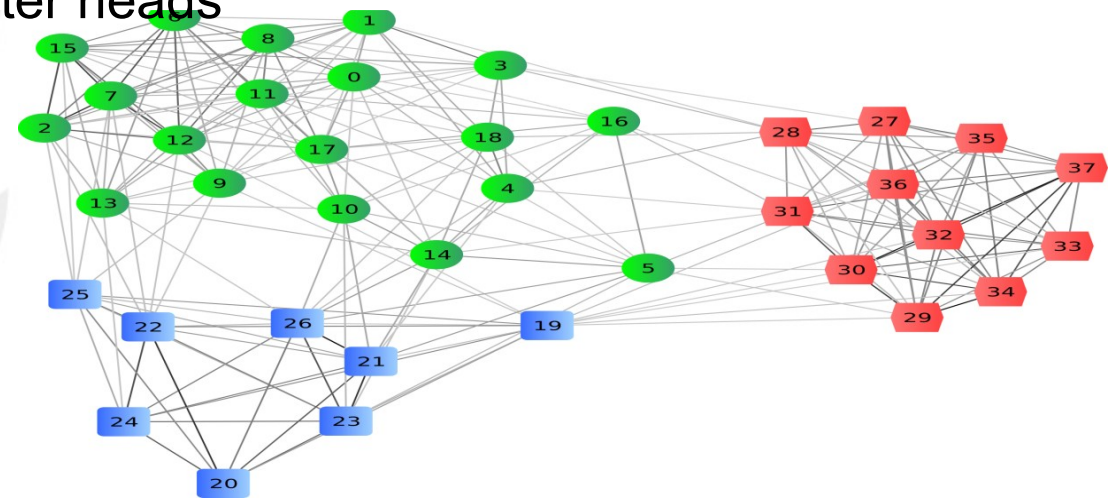
- When BW is low (crit. Level 3)
- Case of WCERT_3
  - Disconnect source 2
  - Transmit only critical frames from source 1
- BW = 0.2012Mpbs
  - With MC – 0.3820s
  - Without MC – 0.8226s
- Trajectory approach
  - 0.62388s
    - Pessimistic … huh!





Conclusion and Future works

- An improved end-to-end response is achieved by adopting mixed-criticality scheduling scheme
  - In comparison with the classical case where all information exhibit the same level of information
    - This ensures freshness of the information
- An interesting extension of our work can be
  - Applying our scheme to a larger network (Scalability)
    - By clustering and cluster heads




THANK YOU!