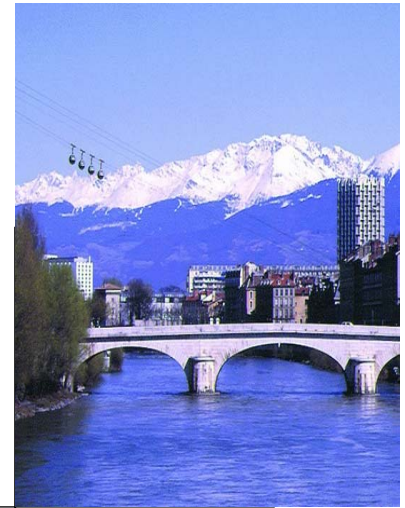
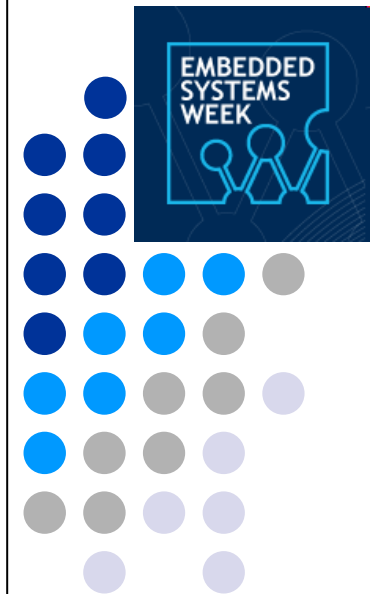


# Smart Cameras and Visual Sensor Networks



## Part 5 Conclusion

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Bernhard Rinner





# Tutorial Agenda

## 1. Introduction

## 2. Smart imager and smart cameras

## 3. Embedded image processing

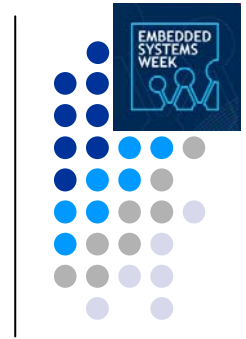
- Heterogeneous Platforms (FPGAs, DSPs ...)
- Dedicated Processors (GPU and cell)

## 4. Visual Sensor Networks

- Distributed Sensing and Processing

## 5. Conclusion

- Research Challenges

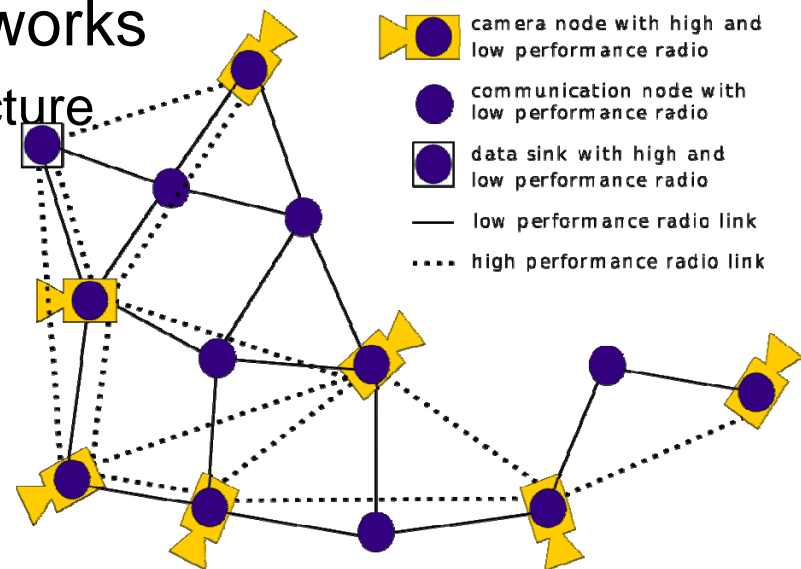


# Research Challenges

# #1: Architecture

## How to design resource-aware nodes and networks

- Low-power (high performance) camera nodes
  - Dedicated platforms: vision processors, PCBs, systems
  - Many examples: CITRIC, NXP
- Visual/Multimedia Sensor Networks
  - Topology and (multi-tier) architecture
  - Multi-radio communication



# #2: Networking

How to process and transfer data in the network



- Ad hoc, p2p communication over wireless channels
  - Providing RT and QoS
  - Eventing and/or streaming
- Dynamic resource management
  - (local) computation, compression, communication, etc.
  - Degree of autonomy: dynamic, adaptive, self-organizing
  - Fault tolerance, scalability
  - Network-level software, middleware

[Doblender\_ACMTECS2009], [Rinner\_ICASSP2007] , [Shin\_2007]

# #3: Distributed Sensing & Processing

Where to place sensors and analyze the data



- Sensor placement, calibration & selection
  - Optimization problem
  - Distributed approaches eg., consensus, game theory  
[Soto\_CVPR2009], [Devarajan\_PIEEE2008]
- Collaborative data analysis
  - Multi-view, multi-temporal, multi-modal
  - Sensor fusion  
[Kushwaha\_ICCCN2008], [Cevher\_TransMM2007]

# #4: Mobility

How to exploit networks of mobile cameras



- Ubiquitous mobile cameras
  - PTZ, vehicles, robotics etc.
  - Mobile phones
- Advanced vision algorithms
  - Ego motion, online calibration
  - Closed-loop control, active vision

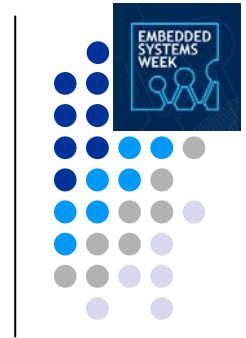
# #5: Usability

How to provide useful services to people

- Ease of deployment, maintenance
  - Self-\* functionality
- Privacy and Security  
[Serpanos\_PIEEE2008]
- Killer application





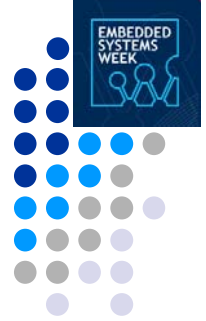


# Potential for Applications



# (Potential) further Applications

- Entertainment (computer games)
  - in 3D environments
- „Smart Rooms / Smart Environments“
  - detection gestures, sign language, room occupancy ...
- Environmental monitoring
  - sensor fusion, habitat monitoring
- Security
  - Safety enhancement (trains, cars), access control, surveillance
- „Virtual Reality“
  - augment real world with digital information
- ...

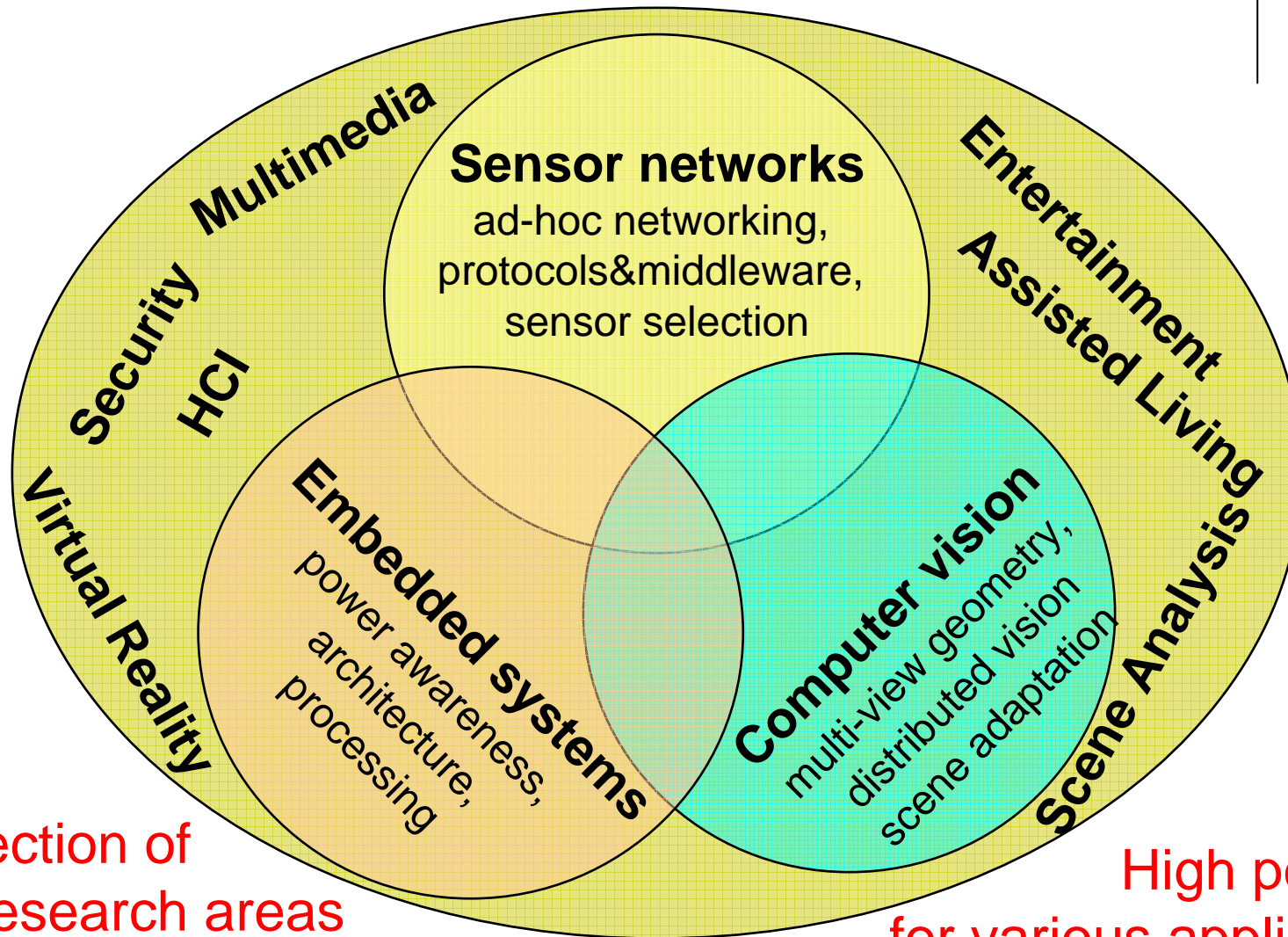


# Smart Cameras

- combine
  - sensing,
  - processing and
  - communication

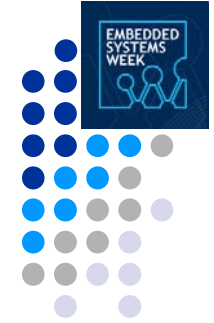
in a single embedded device
- perform **image and video analysis** in **real-time** closely located at the sensor and transfer only the results
- **collaborate** with other cameras in the network (multi-camera system)

# Interdisciplinary Research



Intersection of "hot" research areas

High potential for various applications



# Further Information

- Tutorial Site

[http://pervasive.uni-klu.ac.at/SCSN\\_tutorial](http://pervasive.uni-klu.ac.at/SCSN_tutorial)