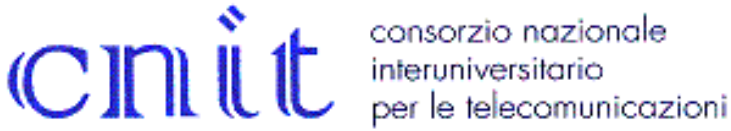
ALMA MATER STUDIORUM - UNIVERSITA' DEGLI STUDI DI BOLOGNA

DEI - Departement Of Electrical, Electronic and Information Engeneering - Cesena

Ph.D. Course in Electronics Engineering, Telecommunications and Information Technology

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA
SEDE DI CESENA



Camera ranking selection algorithms and aggregated data transmission for large area monitoring

Ph.D. Student:

SIMONE MORETTI

simone.moretti6@unibo.it

Supervisor:

Prof. Ing. MARCO CHIANI

Co-Supervisors:

Ing. ENRICO PAOLINI / Ing. MATTEO MAZZOTTI

XXVIII Cycle

Academic Year 2014

Outline

- The FP7 European Project *CONCERTO*
- The camera selection problem in the context of large camera networks
- Transmission of multiple health-related heterogeneous information from emergency scenarios
- Large Camera Networks simulations and camera ranking testing
- Numerical evaluations on the received video quality

Content and cOntext aware delivery

for

iNteraCtive multimedia healthcaRe applications

Website: www.ict-concerto.eu

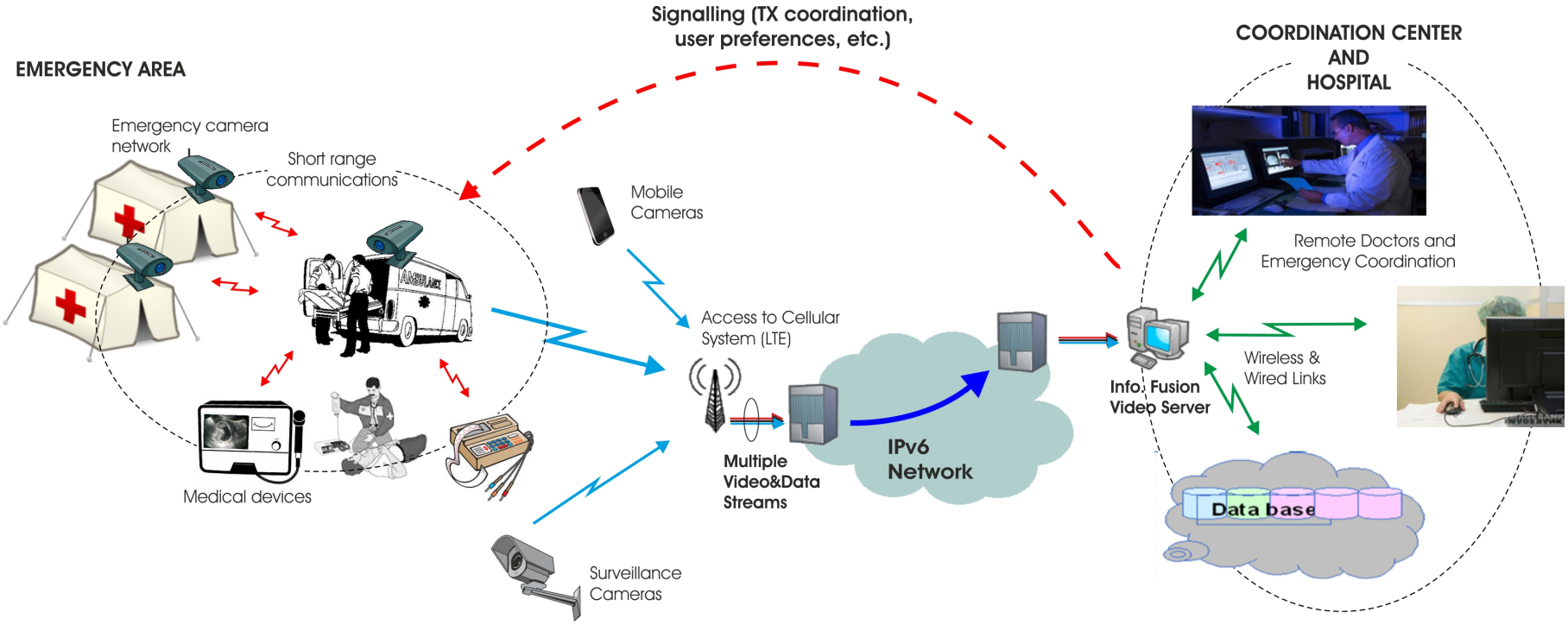
Twitter: @ICTConcerto

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration

Content and cOntext aware delivery for iNteraCtive multimedia healthcaRe applications

- CONCERTO is seeking to:
  - Overcome the actual limitations of the existing delivery mechanism
  - Facilitate new, immersive and interactive eHealth services by studying and designing a new media delivery platform
- CONCERTO intends to:
  - Design and validate new techniques for media content fusion, delivery and interactive access, while specifically addressing the strict requirements of healthcare services
  - Provide high a Quality of Experience (QoE) for medics, which is a necessary condition for providing flawless medical diagnosing of the highest reliability
- CONCERTO will offer:
  - The possibility to physicians, patients, etc., to capture media content, send it wirelessly and navigate through it thus improving remote assistance

Heterogeneous information delivery from emergency scenarios



- Multiple patients involved
- Several cameras monitoring the area
- Need to transmit and exploit/fuse multiple data flows
- Heterogeneous and static sources that need coordination
- Stringent medical data requirements (transmission time, BER, video quality, etc.) to be fulfilled

Camera selection problem in the context of large camera networks

- **Scenario:** video monitored emergency area
- **Objective:** select a subset of cameras in the network
- **Idea:** camera ranking algorithm based on specific ranking criteria

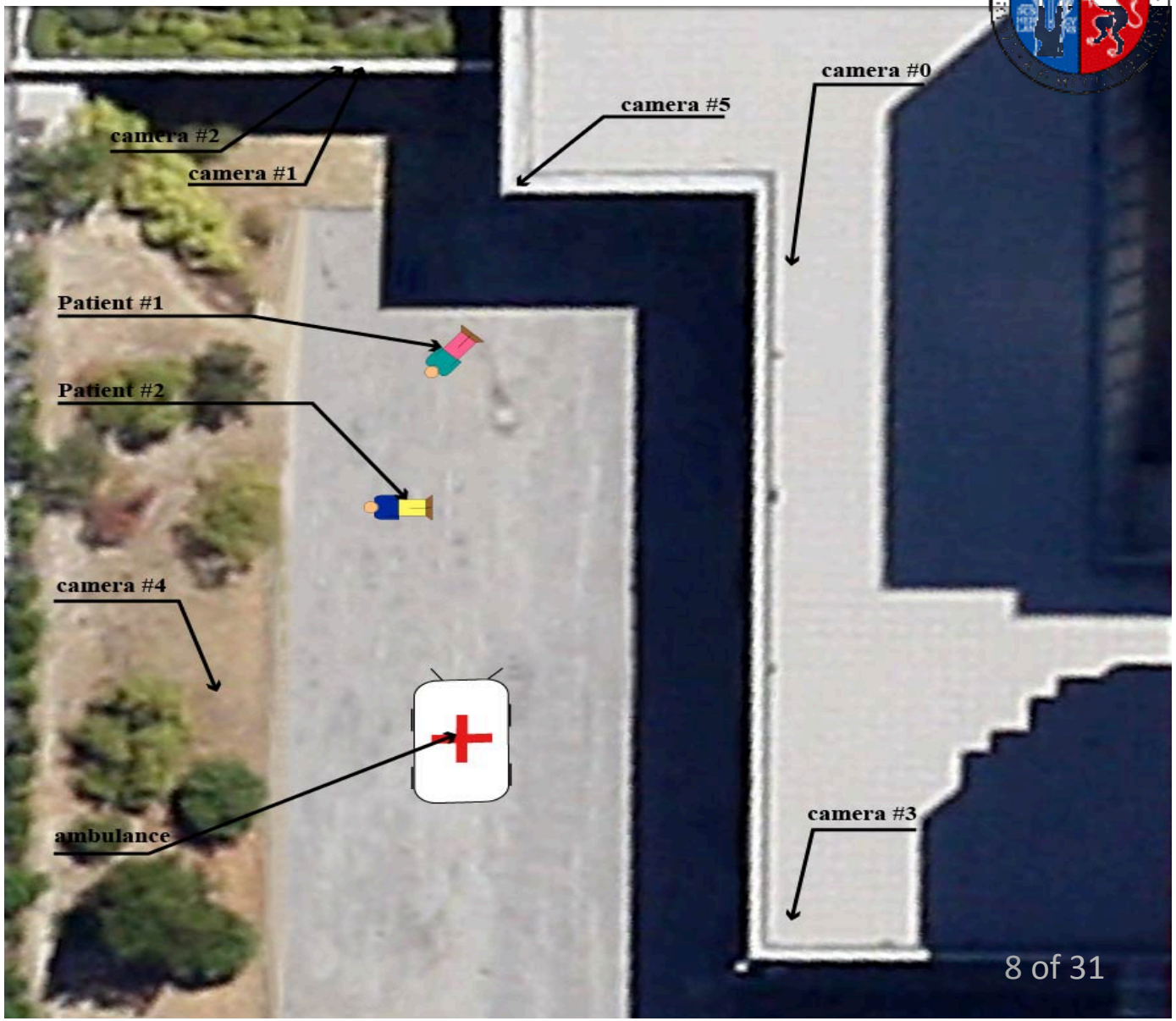
- **Benefits:**
  - ✓ maximize the QoE for the final user
  - ✓ optimize the usage of distributed hardware resources
  - ✓ optimize the usage of radio resources for video transmissions

Camera selection problem in the context of large camera networks

- Monitored emergency area

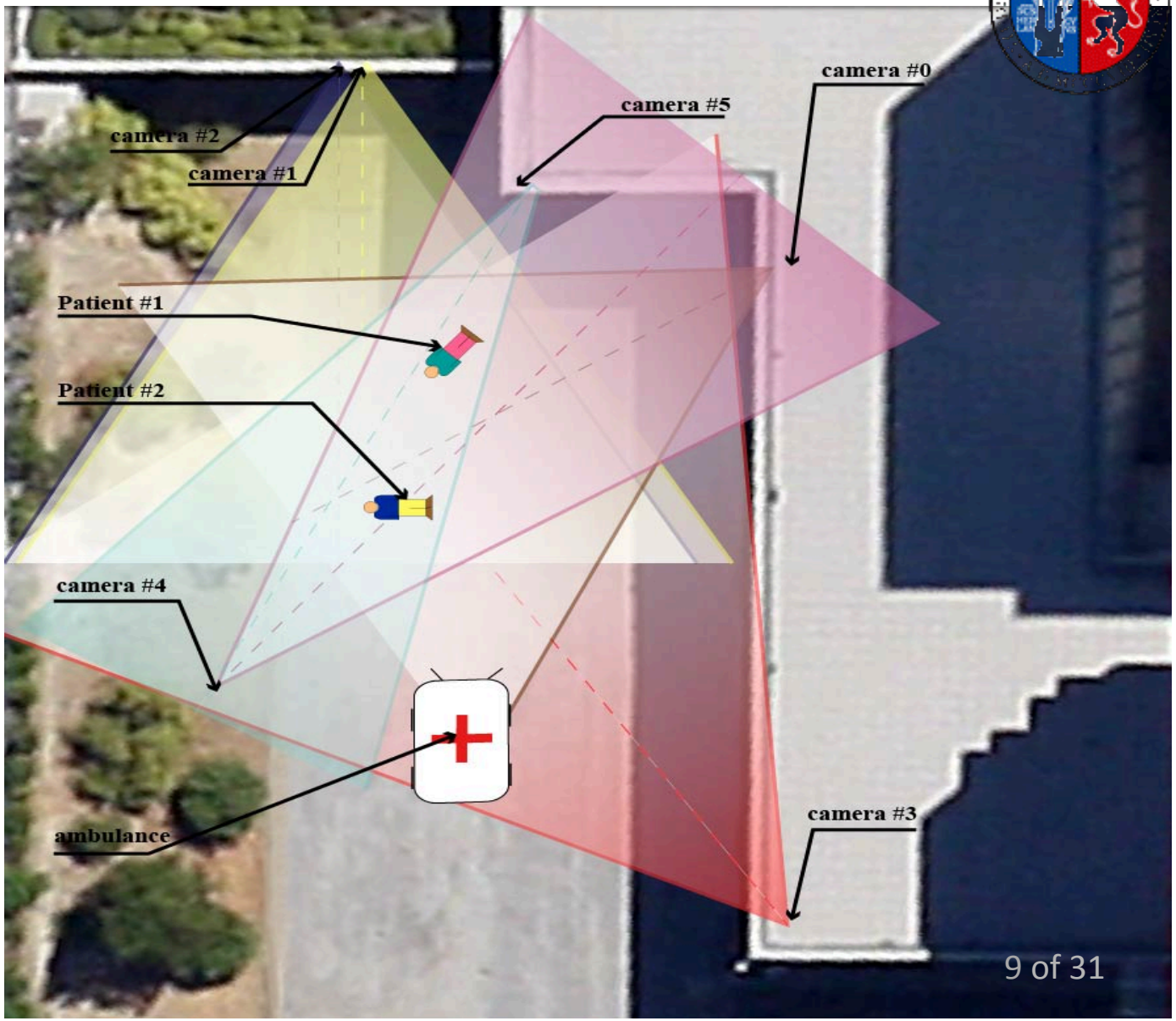
Camera selection problem in the context of large camera networks

- Monitored emergency area
- Cameras placed in different positions



Camera selection problem in the context of large camera networks

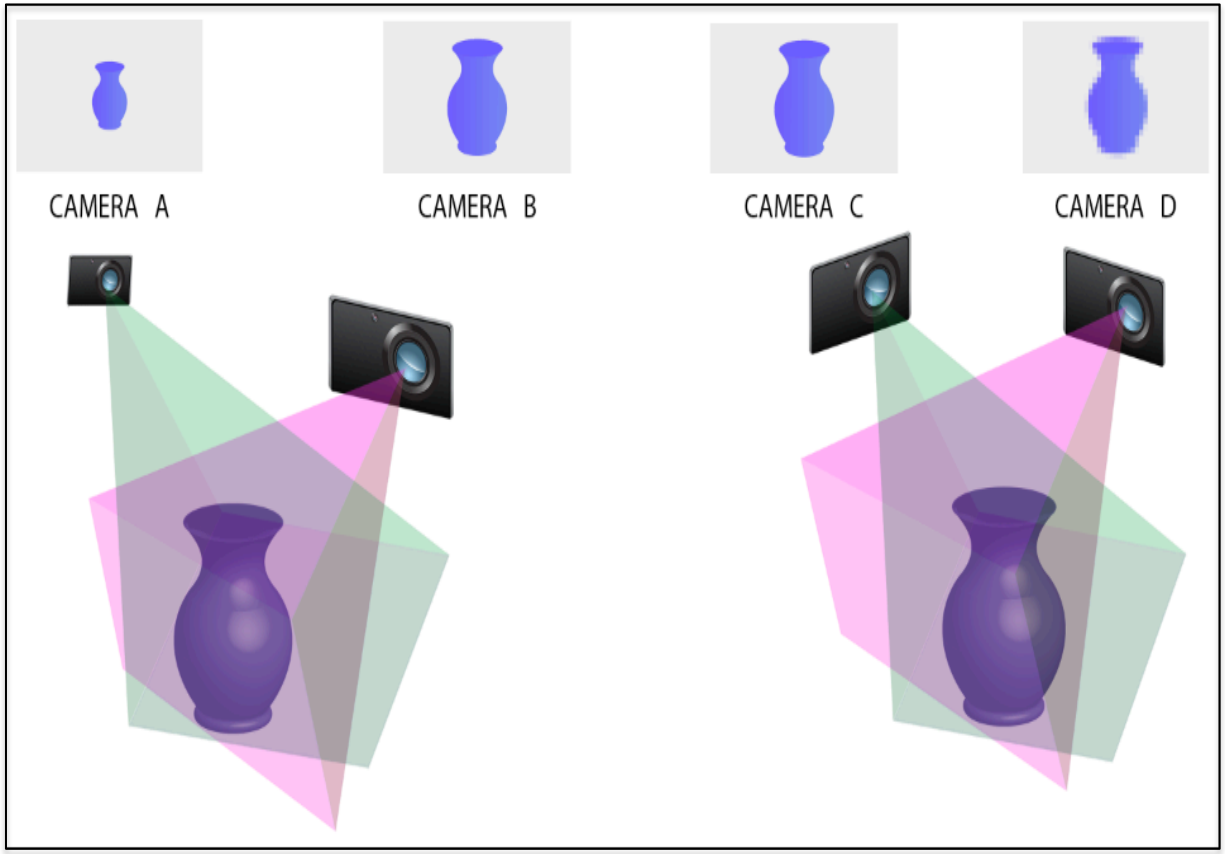
- Monitored emergency area
- Cameras placed in different positions
- Camera monitoring functionality based on orientation and field of view
- Some sub-areas commonly covered by two or more cameras



Camera selection problem in the context of large camera networks

- Monitored emergency area
- Cameras placed in different positions
- Camera monitoring functionality based on orientation and field of view
- Some sub-areas commonly covered by two or more cameras
- Simulation of a realistic emergency scenario in the Hospital of Perugia.

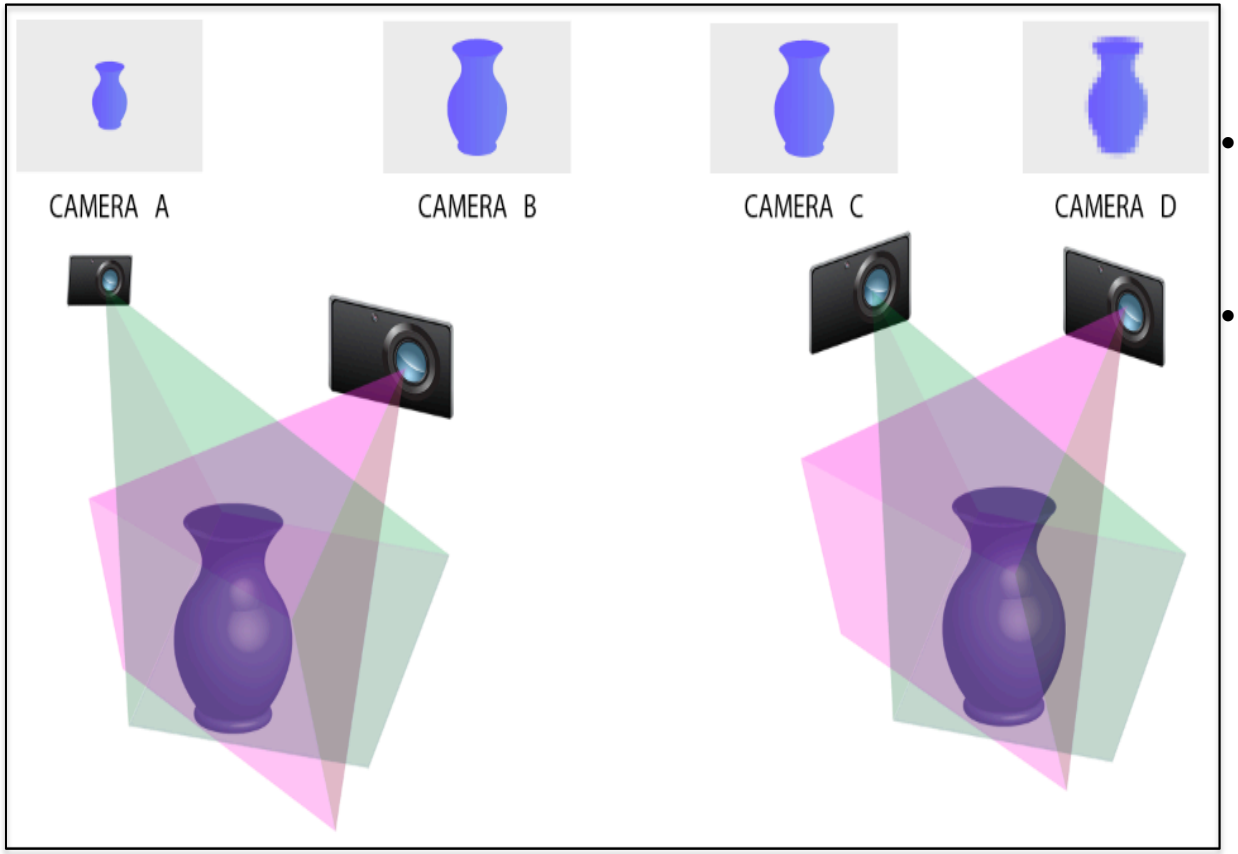
Camera selection problem in the context of large camera networks



- In this example we would reproduce the same object in two different cases.

[*] S. Moretti, M. Mazzotti and Marco Chiani. Camera ranking selection algorithms for large area monitoring. 2014. In submission

Camera selection problem in the context of large camera networks



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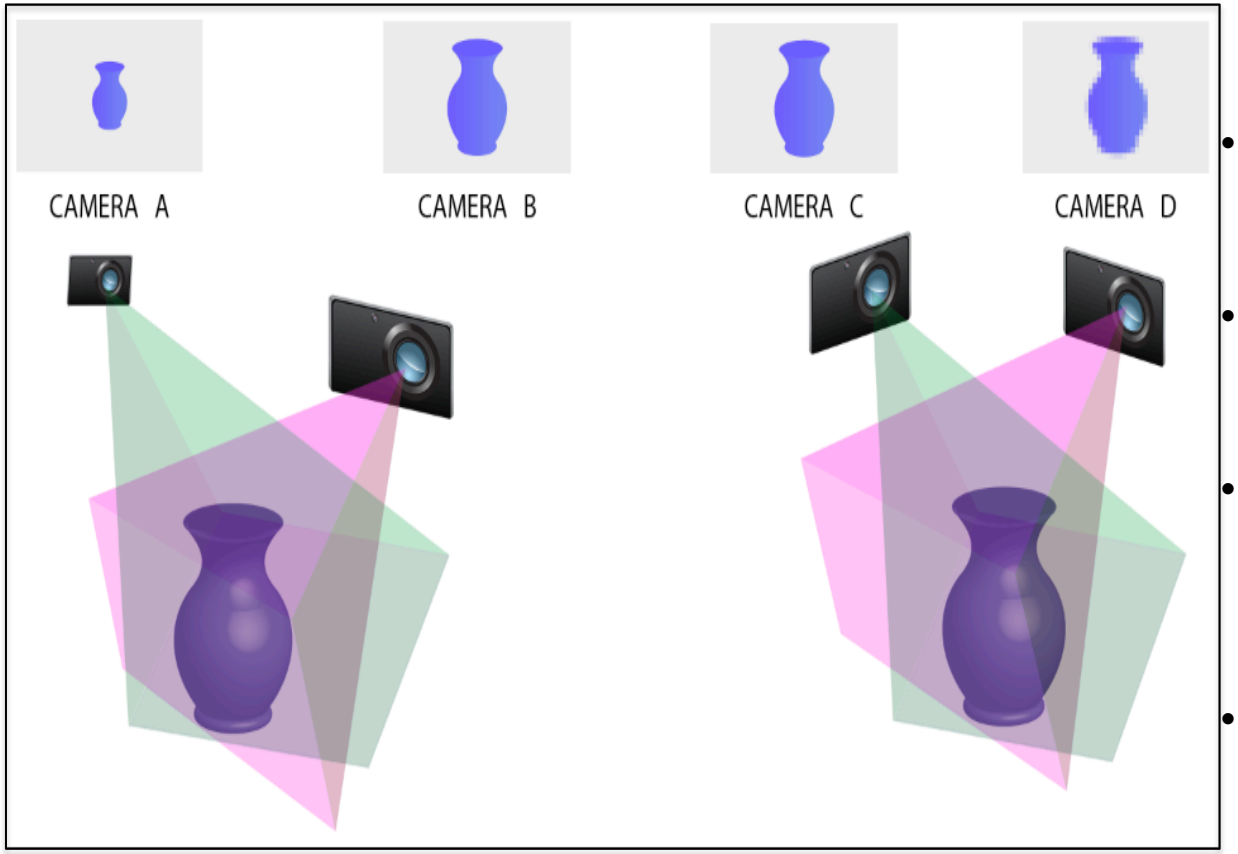

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- **CAMERA A VS CAMERA B:** same resolution, different distances.
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- Increasing the distance, the projection of the object on the image plane gets smaller dimensions,
- the closer is the object to the camera, the more detailed is the projection.

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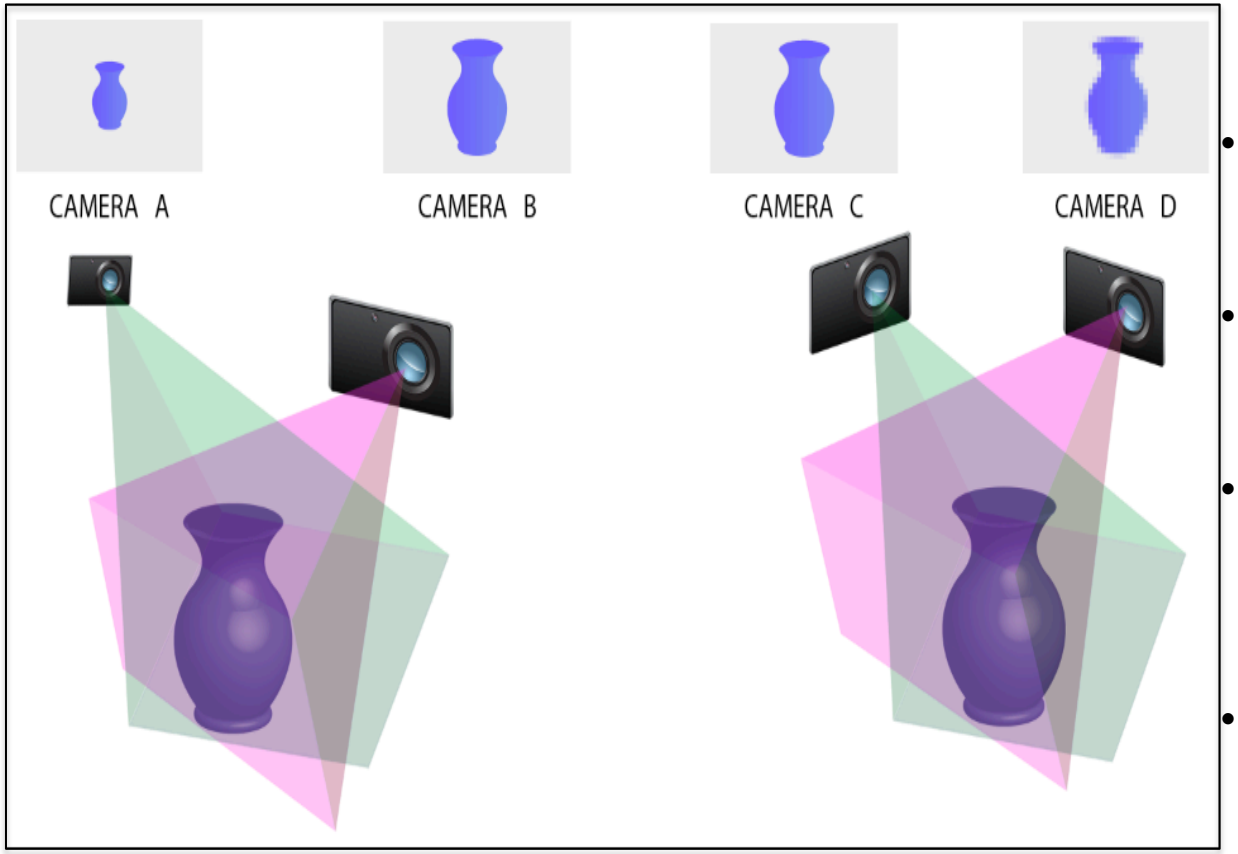

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- Increasing the distance, the projection of the object on the image plane gets smaller dimensions,
- the closer is the object to the camera, the more detailed is the projection.

- Increasing the camera resolution high-level of details are still guaranteed even if the object is placed far away from the camera.
- We propose as camera ranking metric the number of **pixel per area (ppa)[*]**

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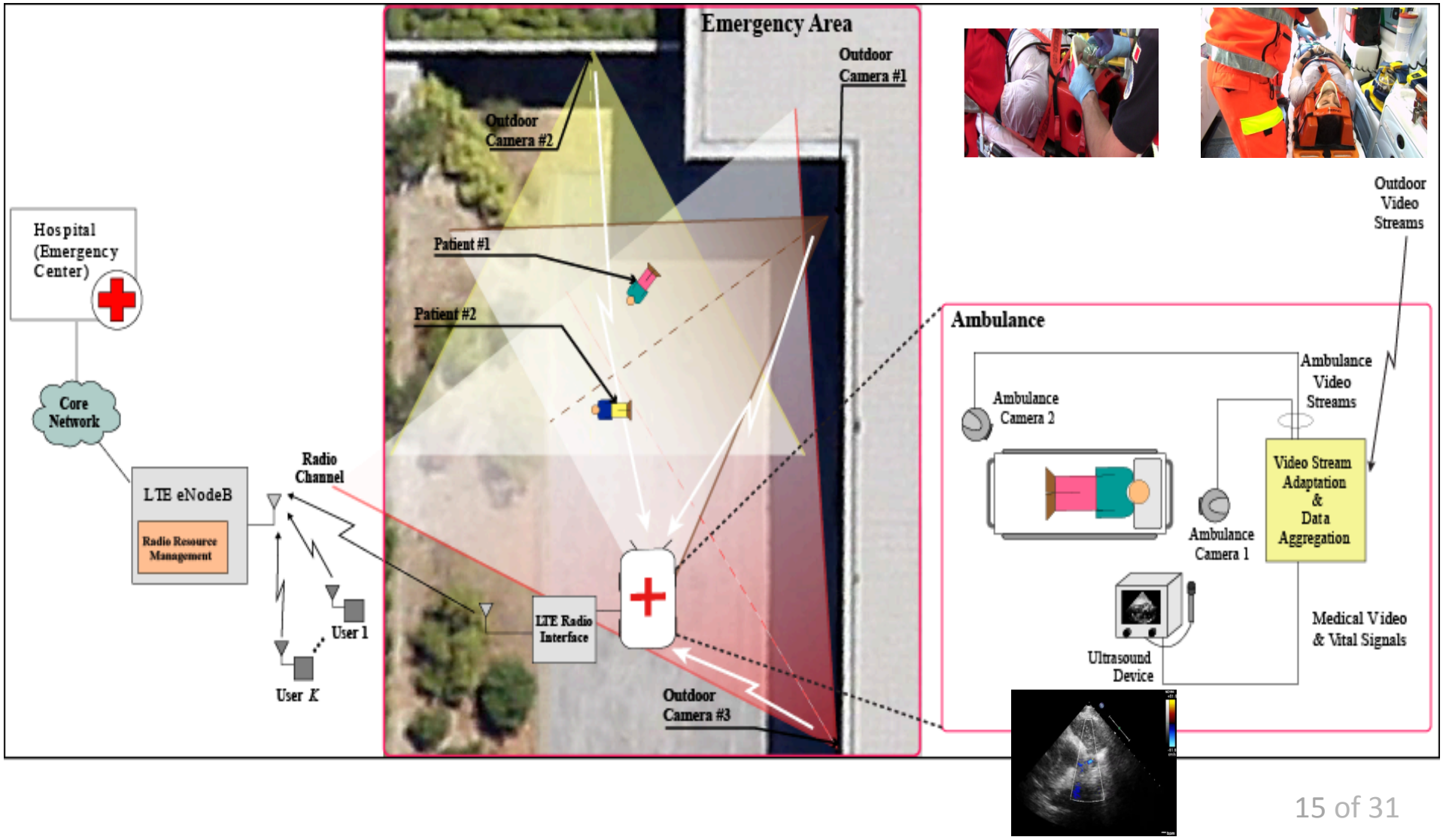
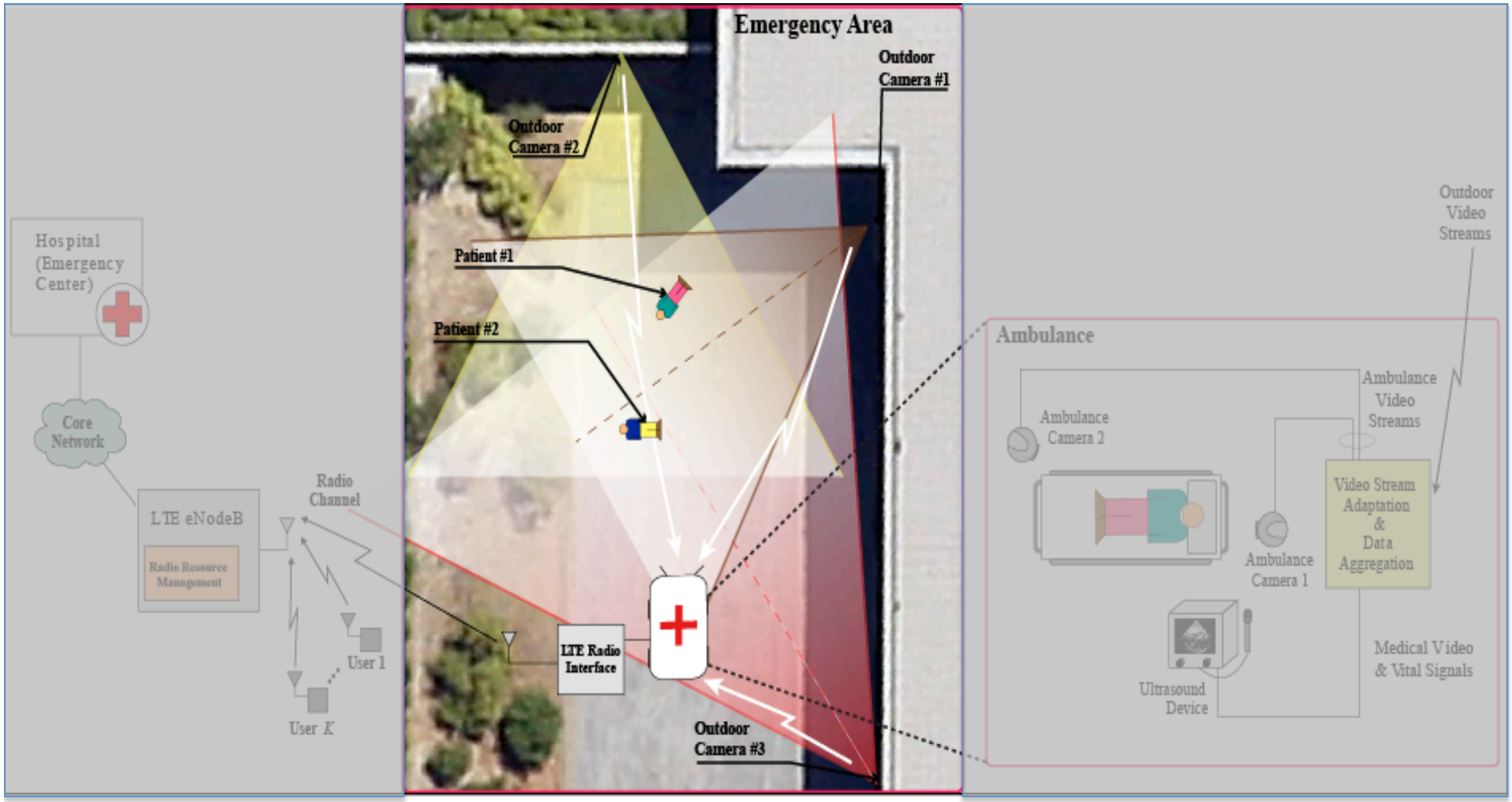
Transmission of multiple health-related heterogeneous information from emergency scenarios



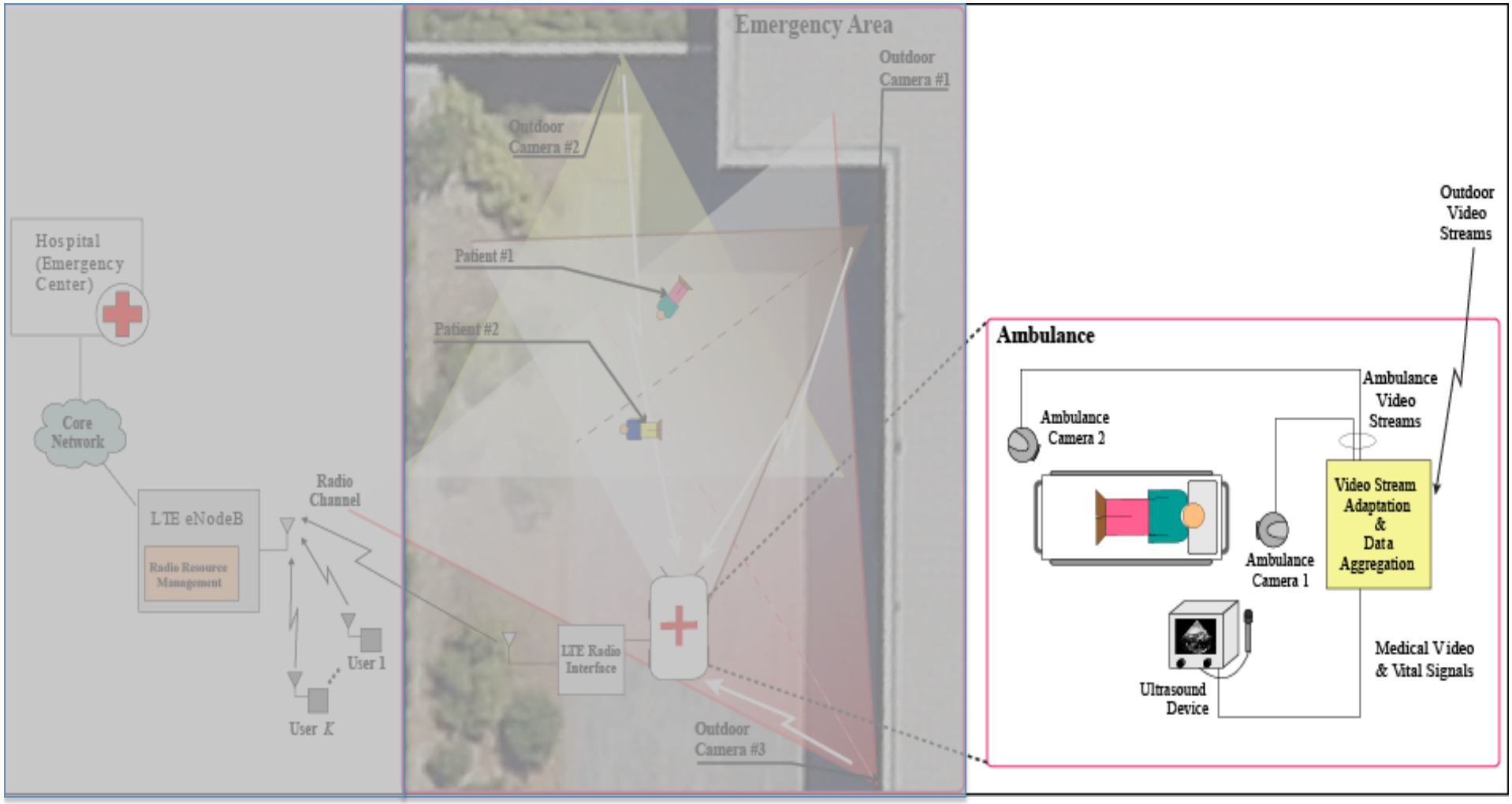
Transmission of multiple health-related heterogeneous information from emergency scenarios

#1: Camera ranking



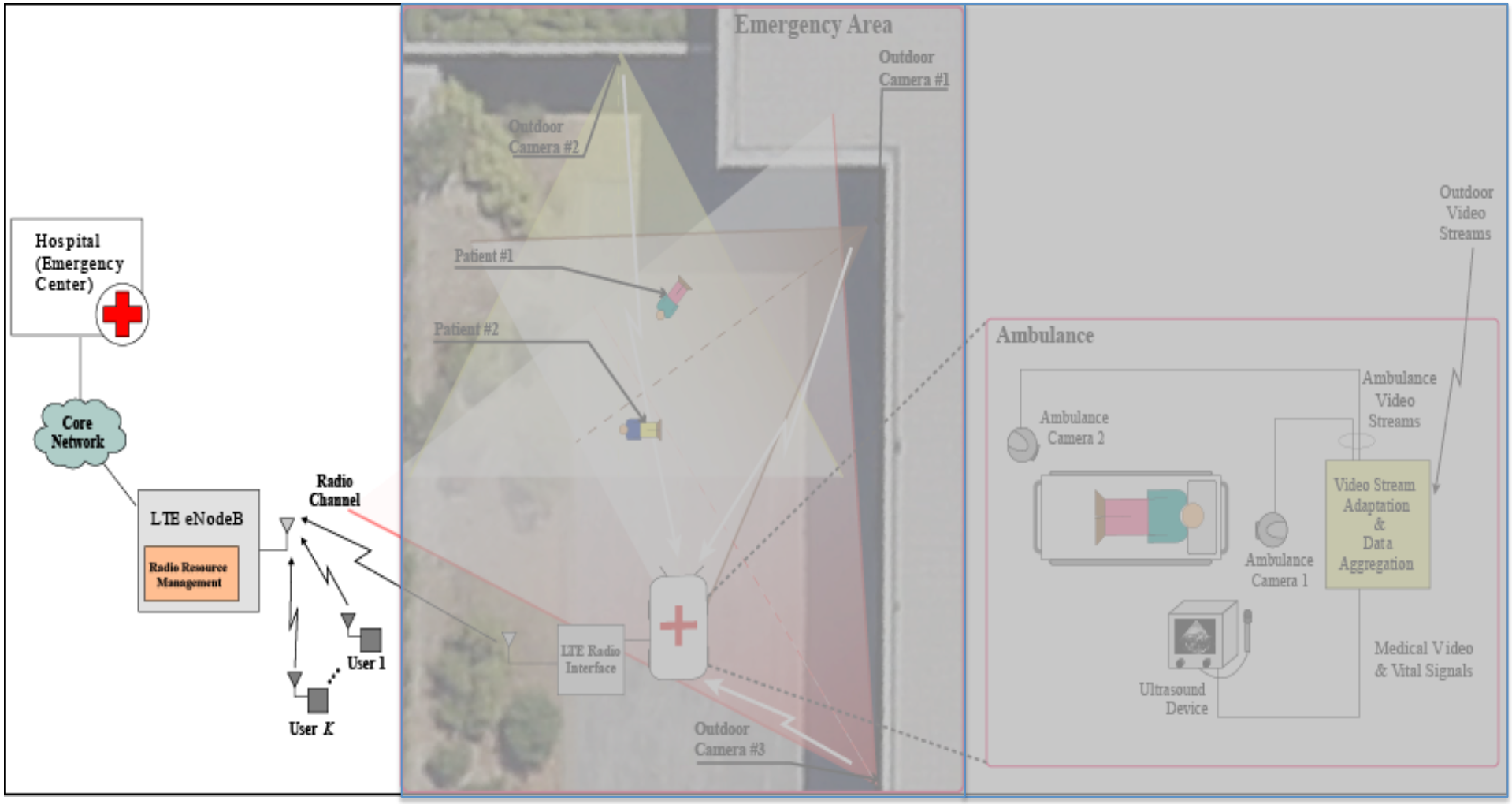
Transmission of multiple health-related heterogeneous information from emergency scenarios

#1: Camera ranking **#2: Video Adaptation**



Transmission of multiple health-related heterogeneous information from emergency scenarios

#3: Video Transmission **#1: Camera ranking** **#2: Video Adaptation**



Transmission of multiple health-related heterogeneous information from emergency scenarios

- Very challenging topic, due to:
  - Limitations and fluctuations of the mobile uplink wireless link
    - Requirement of a certain level of QoS
  - Real-time video streaming
    - Source adaptation
  - Heterogeneous video content (diagnostic vs ambient)
    - Require prioritization based on video quality

Transmission of multiple health-related heterogeneous information from emergency scenarios

- **Dynamic rate adaptation strategy**
  - Maximize the overall video quality by fulfilling the available GBR
  - Minimize the weighted quality difference among the different videos
  - Minimum and maximum rate constraints

$$\sum_{v \in \mathcal{V}} \bar{H} F_v(D_v) = \bar{R}_0$$

$$\Delta(D_i, D_j; w_i, w_j) = 0$$

$$F_v^{\min} < F_v < F_v^{\max}$$

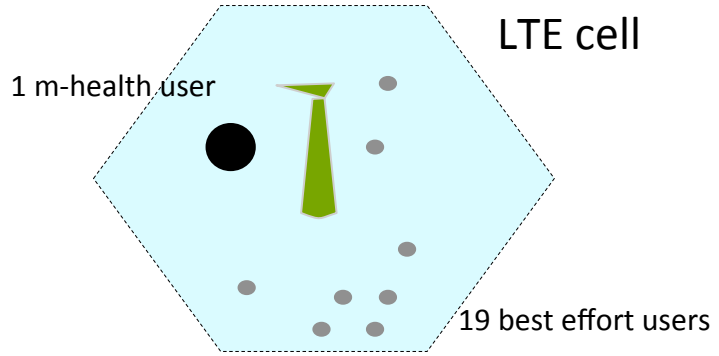
- $\bar{R}_0$ GBR provided to the Ambulance (m-health user)
- $\bar{H}$ Overhead Factor
- $F_v(D_v)$ Source rate of videos (function of the distortion D)
- w_v Priority weight of video v
- $\Delta(D_i, D_j; w_i, w_j)$ Weighted distortion difference metric to take into account min./max.rate constraints

S. Cicalò, M. Mazzotti, S. Moretti, V. Tralli, M. Chiani - Cross Layer Optimization for m-Health SVC Multiple Video Transmission over LTE Uplink 2013 15th International Conference on eHealth Networking Application and Services

Transmission of multiple health-related heterogeneous information from emergency scenarios

Physical Layer

Cell Layout	Single Cell with 3 Sectors
System Bandwidth	5 MHz
Number of Users	20
GBR user	Ambulance
GBR values [Mbps]	2, 3, 4, 4.5,5, 6, 7
Channel Model	ITU ext. Vehicular A
Shadowing Model	Log-normal (std dev. 6dB)

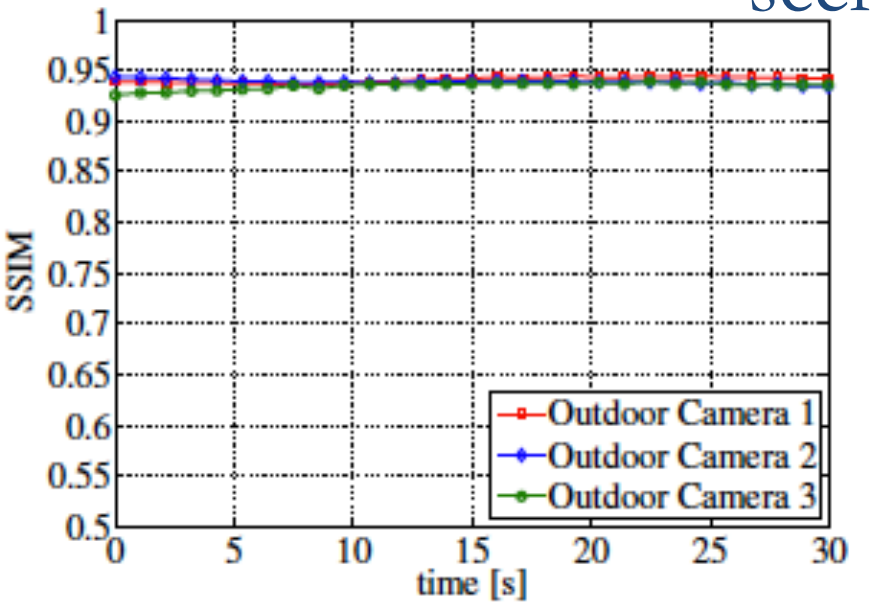


Application Layer

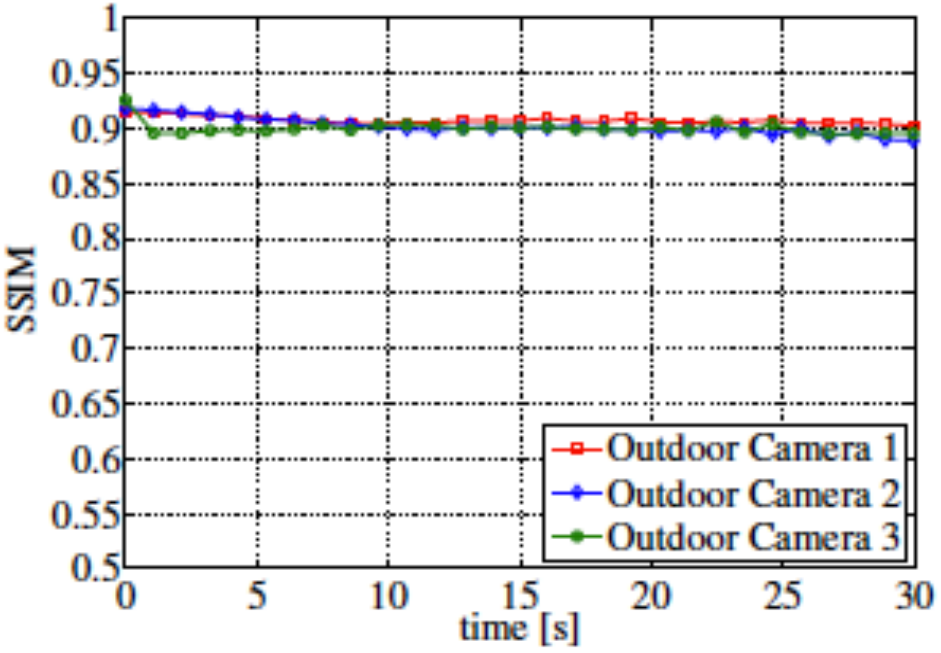
Number of video	3 outdoor 3 ambulance (2 ambient 1 ultrasound)
Resolution	1024x720 (ambient) 640x480 (ultrasound)
Frame Rate	30 fps
Gop Size	8
IDR period	32
SVC layers	2
MGS layers	5

Video Priority	**1 (Ambient outdoor)** **2 (Ambient in the Ambulance)** **3 (Ultrasound)**
Adaptation Interval	About 1 Sec (IDR time interval)
Play-out deadline	200 ms
Video Quality Metric	SSIM

Transmission of multiple health-related heterogeneous information from emergency scenarios

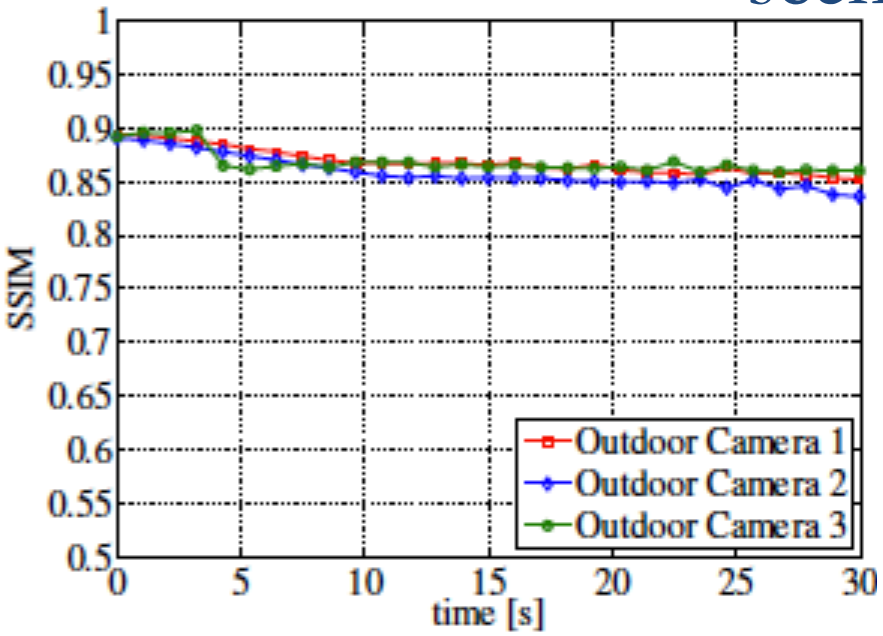


(a) GBR $\bar{R}_0 = 5.5$ Mbps

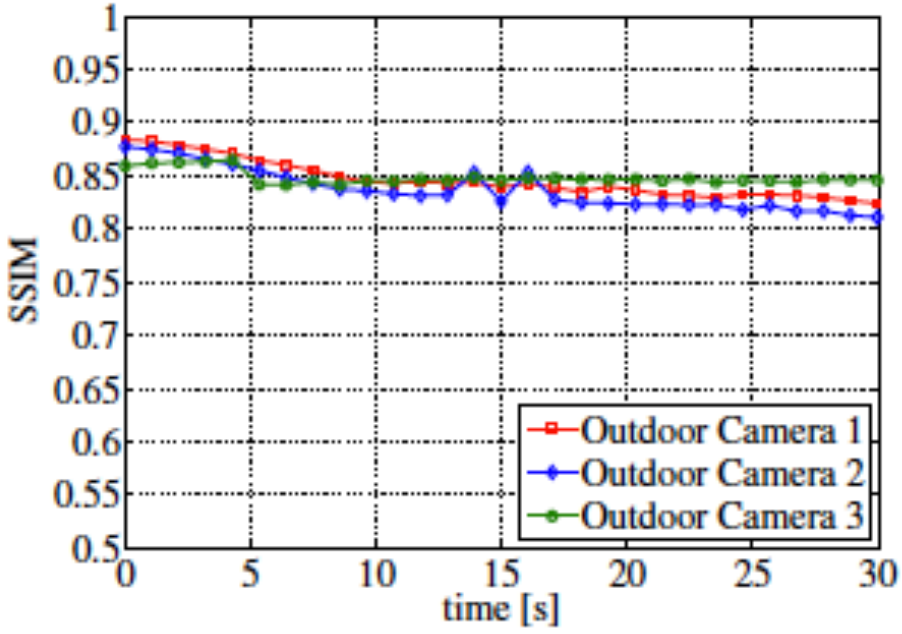


(b) GBR $\bar{R}_0 = 3.5$ Mbps

Transmission of multiple health-related heterogeneous information from emergency scenarios

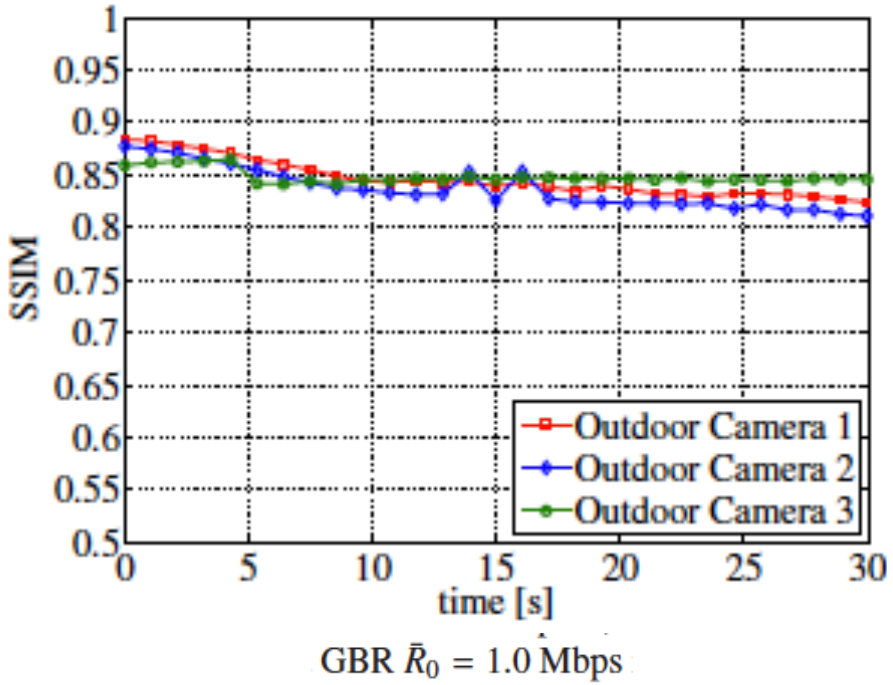


(c) GBR $\bar{R}_0 = 1.8$ Mbps



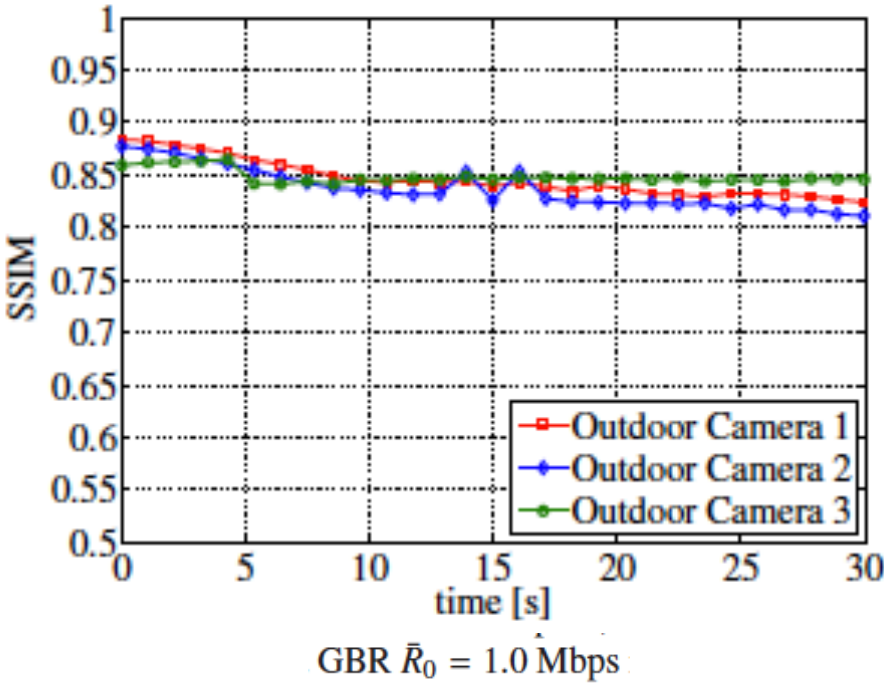
GBR $\bar{R}_0 = 1.0$ Mbps

Transmission of multiple health-related heterogeneous information from emergency scenarios

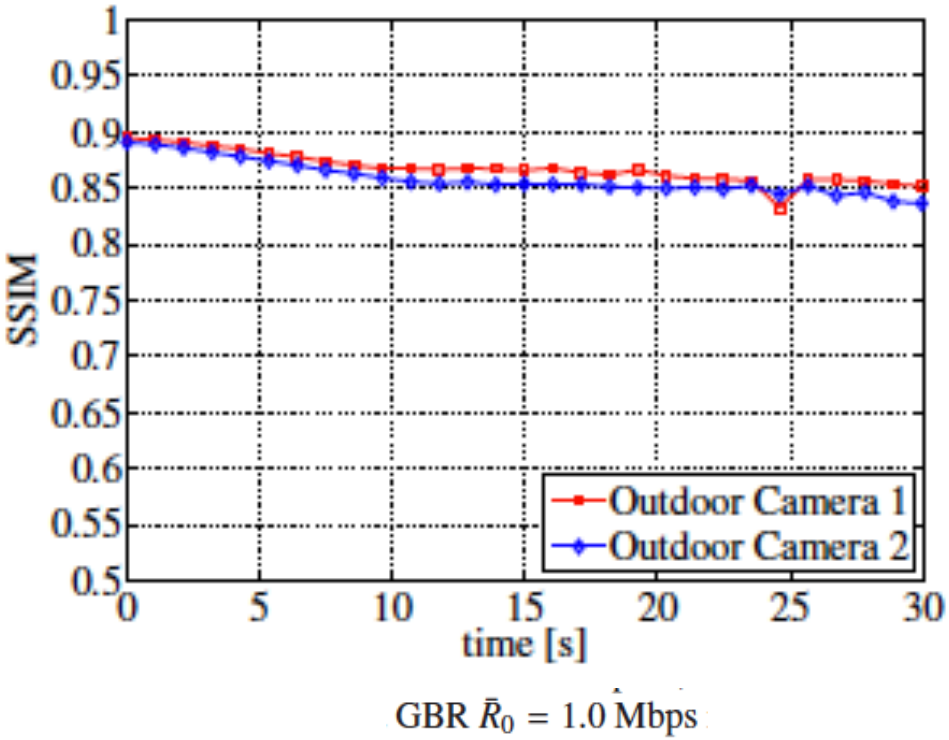


S. Moretti, S. Cicalò, M. Mazzotti, V. Tralli, M. Chiani - Content/Context-Aware Multiple Camera Selection and Video Adaptation for the Support of m-Health Service,s 2014, International conference on selected topics in Mobile and Wireless Networking (MoWNet)

Transmission of multiple health-related heterogeneous information from emergency scenarios



- Video Adaptation
- Video Selection based on camera ranking results
- Quality requirements satisfied!



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Transmission of multiple health-related heterogeneous information from emergency scenarios

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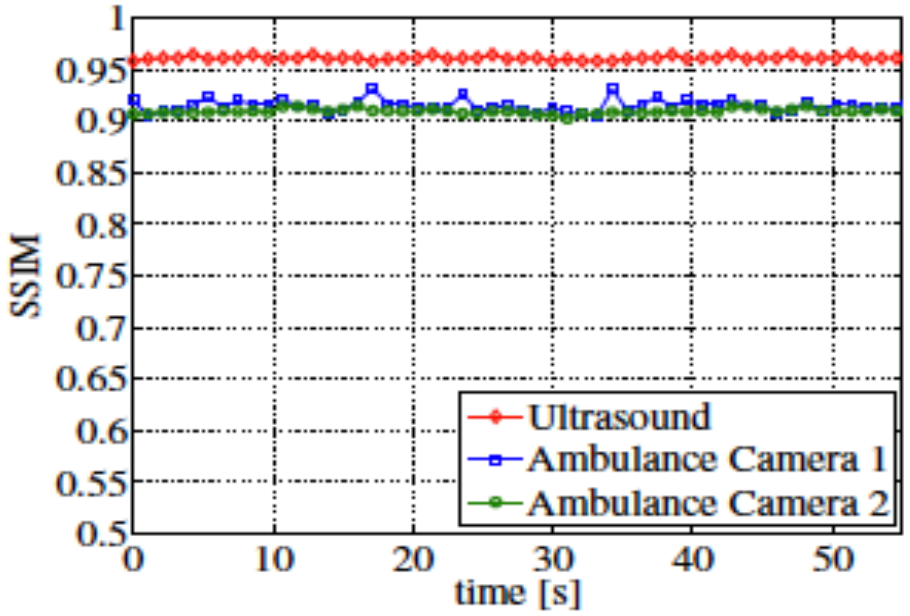

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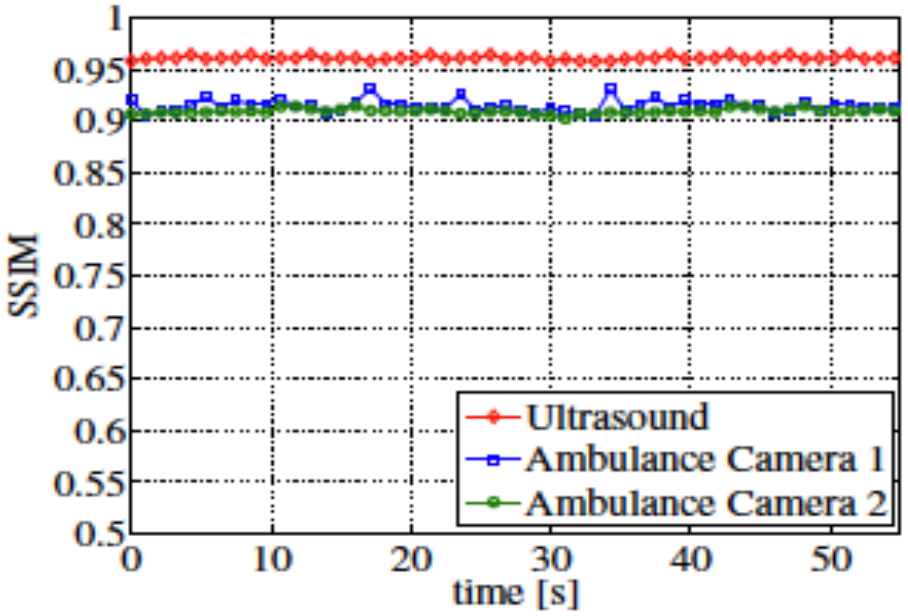

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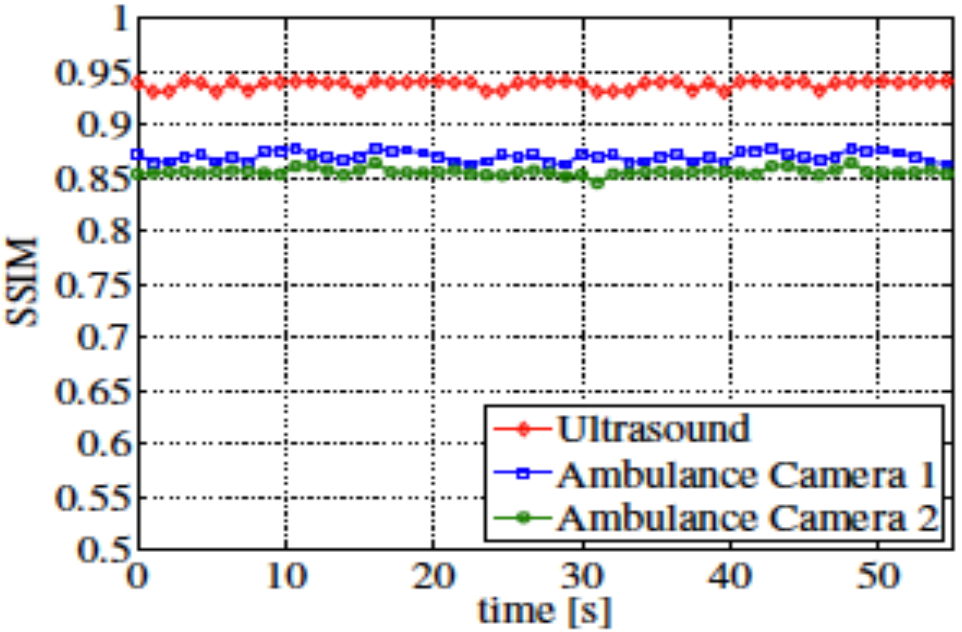
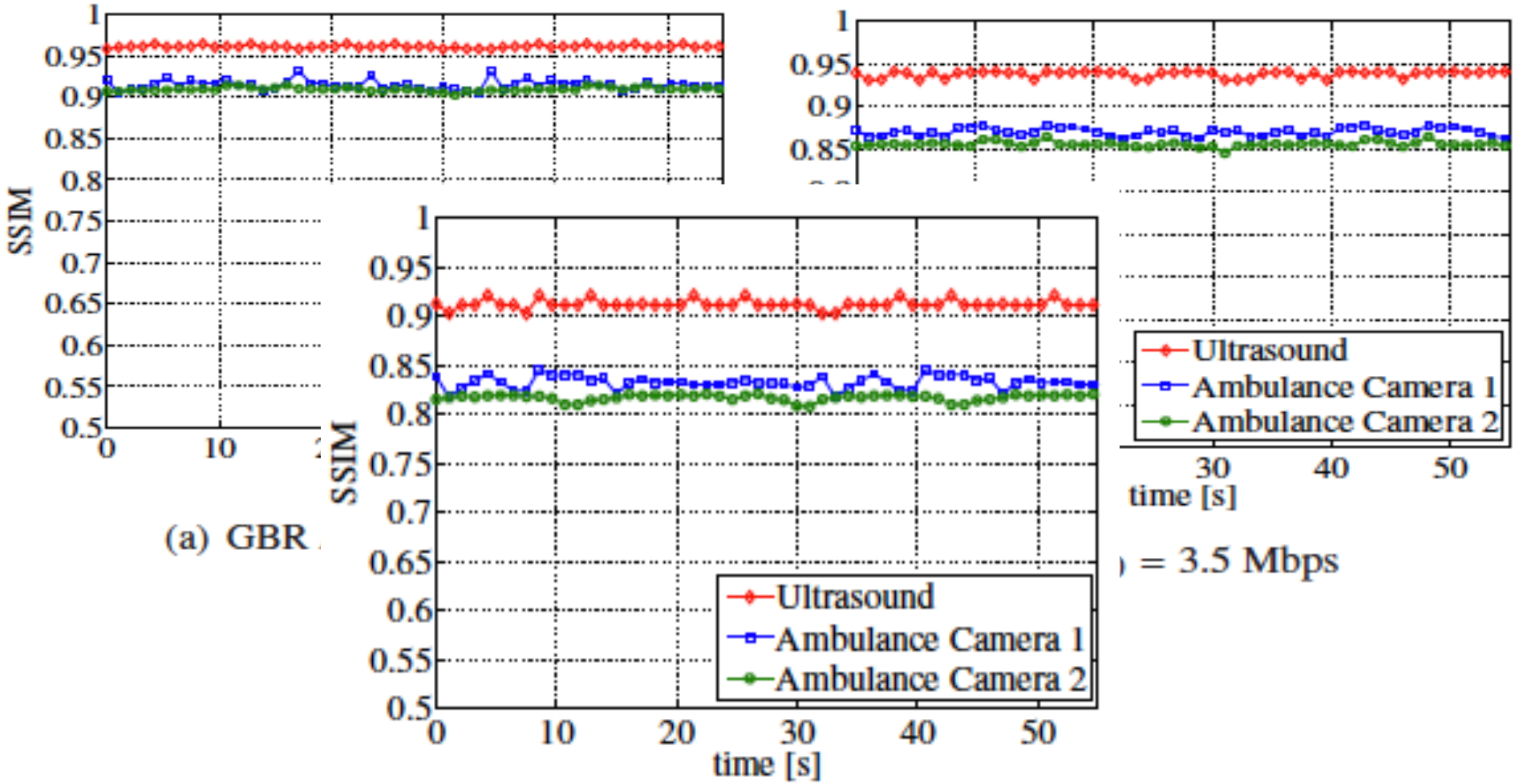


(b) GBR $\bar{R}_0 = 3.5$ Mbps

Transmission of multiple health-related heterogeneous information from emergency scenarios



Conclusions

- Study of camera ranking algorithms in the context of large camera networks:
  - Ranking criteria based on the final perceived video quality
  - Ranking strategy utilised for optimize the hardware resources
  - Camera selection results used as input for the video adaptation
- Multiple video and data transmission from emergency areas:
  - Proposal of a new multiple SVC video adaptation and aggregation strategy for LTE
  - Optimal end-to-end multiple video qualities in one single LTE cell
  - Quality Prioritization of the video data flows generated by the m-health user
  - Deliver medical information with sufficiently high quality to perform preliminary diagnosis and ambient videos tuned according to quality fairness criteria

Thank you for your attention!