BOSS

On BOard wireless Secured video Surveillance

http://www.celtic-boss.org

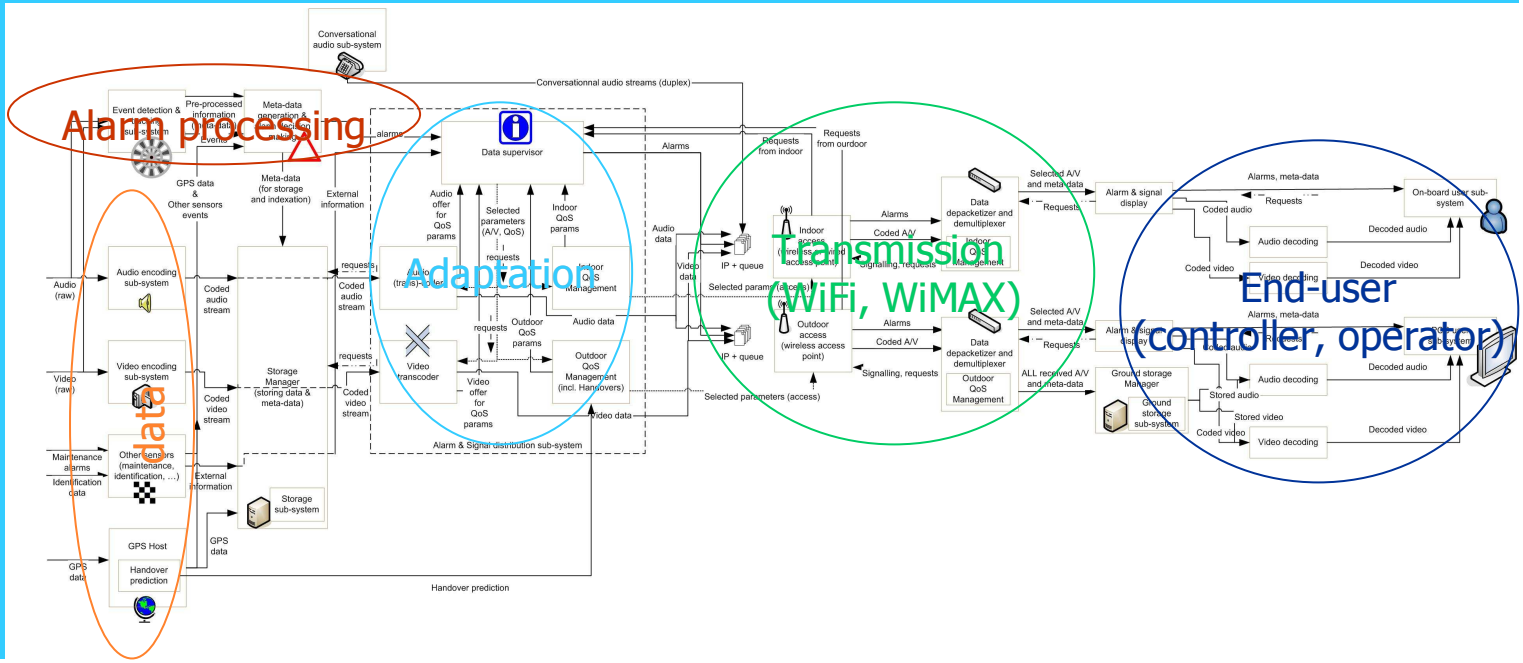
Objectives

- Propose a reliable solution to increase the security of passengers inside commuter trains
- Design of a technical solution allowing the deployment of a security solution for passengers against attacks/crisis, but also follow-up of maintenance issues for the rolling stock
- Establishment of a high data-rate communication system between trains and the wayside to allow distant monitoring of passengers security and preventive maintenance

Key technical improvements

- Adaptation of the stream to be transmitted based on available resources
- Integration of abnormal event detection to determine level of importance for the different data streams
- Vertical and horizontal efficient handover management through Mobile IPv6 and GPS aided handover prediction
- System operable from the way-side through SIP/RTSP
- Common signalling system for all sensor data : audio, video and maintenance

BOSS system specifications



Key technologies and standards

- Radio access: WiMAX / HSUPA / WiFi
- IPv6 and its mobile extension MIPv6
- DCCP transport protocol
- RTSP with specific methods for adaptation control
- H.264/AVC video and its scalable extension H.264/SVC
- AAC audio
- SIP signalling

Key message

Enhancement of passengers security is now possible thanks to monitoring inside trains and reporting to the way-side!

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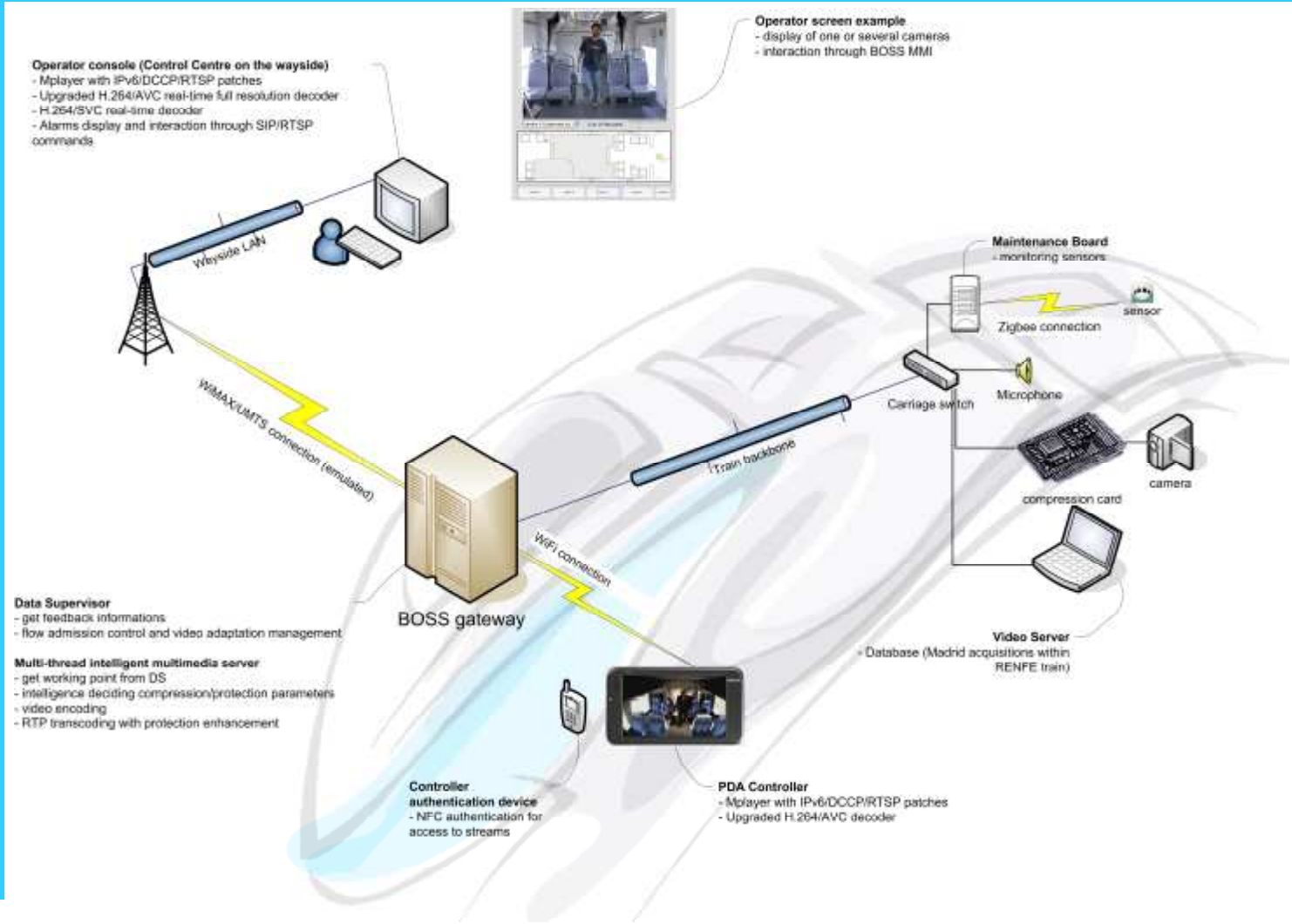
BOSS demonstrator



Main features

- Multi-thread video and audio transmission towards train controller and control centre operator
- Adaptation of the video streams to the wireless channel constraints (based on available bit rate, link quality)
- Data flows balancing management over different wireless interfaces (with Quality of Service management)

Roadmap to final demonstration

- Live demonstration in a RENFE train in Q2 2009
- Camera selection and video inspection by the controller and the operator
- Event detection of previously recorded video and audio data from a real train and corresponding automatic alarm delivery to the train controller and the control centre operator
- Audio streams management

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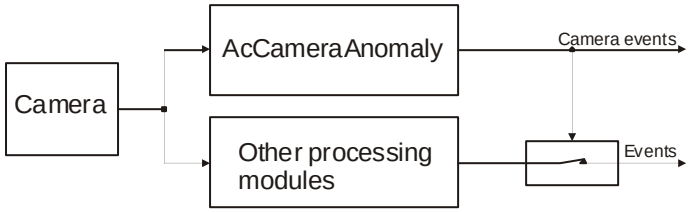
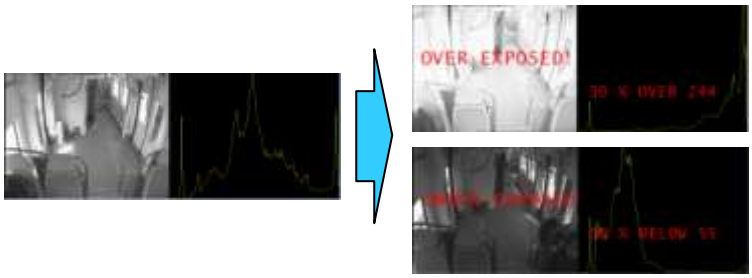
Technical improvements : detection of abnormal video events

- Camera anomaly detection chain



- Over/under-exposure detection

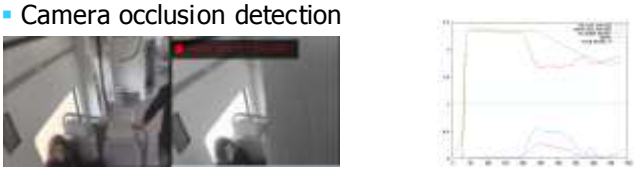


- Detected events:
  - Video loss detection
  - Overexposure, underexposure
  - Camera displacement
  - Camera occlusion
  - Blur

- Displacement detection

- Computational load
  - About 0.6 ms per image, all detectors running (Centrino dual core 2.4 GHz CPU)
  - Blur detection the most computer-intensive

- Camera occlusion detection



Technical improvements in video compression and video protection

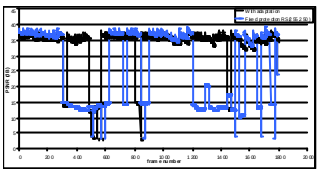
- Video robustness enhancement
  - Concealment of errors and losses
  - Introduction of error protection capability via reed-Solomon codes
- Adaptation of the protection to transmission conditions
  - the intelligent transcoder allows to optimize repartition of bandwidth used between data (source bits) and protection

Visual result for ITU-T 'Mobile calendar' sequence : interest of introduction of embedded error protection

Configuration :
Video sequence QCIF, 15Hz, BSC (10^{-4})
without protection vs. with RS(128,120)

Visual result for BOSS 'Anomaly' sequence: embedding fixed protection is not enough

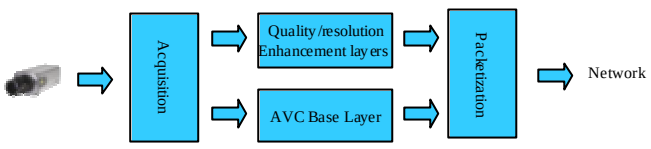
Configuration :
Video sequence CIF, 30Hz, BSC (4.10^{-4})
adapted RS(255,250), RS(128,120), RS(255,191) vs. with RS(128,120)



PSNR evolution with time with or without adaptation for BOSS 'Anomaly' sequence and varying channel conditions

- Encoder, transcoder and decoder computational load
  - runs in real-time over single core laptops
  - transcoding/transdecoding can be used over any existing H.264 codec

- H.264 video encoding board
  - Scalable compression platform suitable for simultaneous streaming/recording
  - Temporal scalability: 25/12.5 fps
  - Spatial scalability: 4CIF, CIF
  - Quality scalability
  - Support for RTP/RTSP



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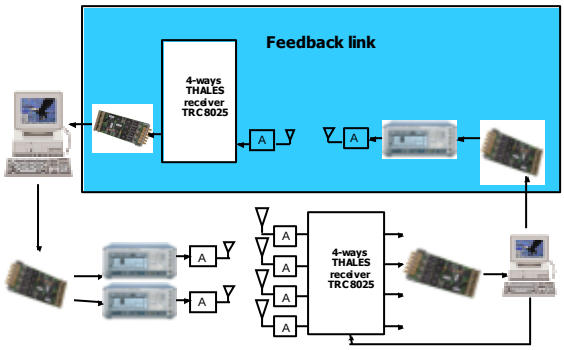
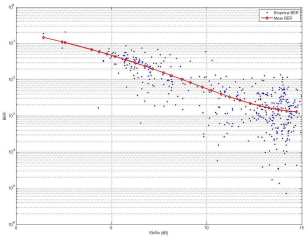
Technical improvements : MIMO techniques for WiMAX-like radio access

- MIMO test-bed



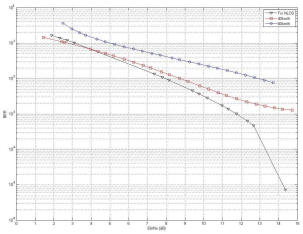
Platform Architecture

Examples of BER mobility performances of simple modem without feedback link



Empirical and Mean BER vs. SNR for uplink communication without feedback link

Configuration :
MIMO 2*2, Q-PSK, Alamouti coding, 40 km/h mobile speed, Sub urban area

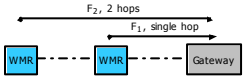


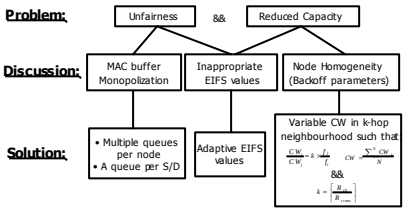
Mean BER vs. SNR for uplink communication and various mobile speed (fix, 40 km/h and 60km/h)

Configuration :
MIMO2*2, Q-PSK, Alamouti coding, 0 or 40 or 60 km/h mobile speed, Sub urban area

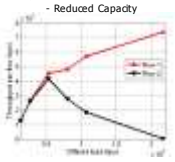
Technical improvement: increasing QoS (throughput & visual quality) through advanced Wi-Fi mesh routing and data flow control admission supervision

- Advanced Wi-Fi mesh routing to ensure connectivity over several carriages

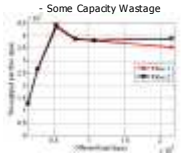




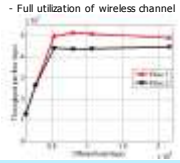
Basic MAC:
-Single hop flow starves the other
- Reduced Capacity



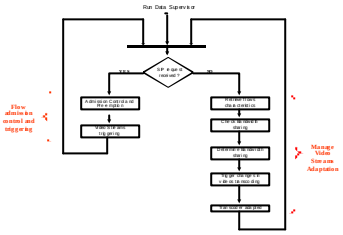
Multiple queues per node
-Significant Improvement in Fairness
- Some Capacity Wastage



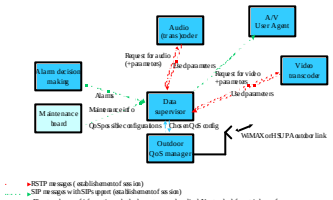
Multiple queues per node + Dynamic CW + Adaptive EIFS
-Significant Improvement in Fairness
- Full utilization of wireless channel



- Data supervision activity for streams admission and protection control
  - retrieving characteristics of video streams currently transmitted
  - retrieving characteristics of used transmission chain current conditions
  - managing video streams adaptation
  - triggering changes in video transcoding
  - control flow admission and perform pre-emption of bandwidth for video streams based on session management and priorities



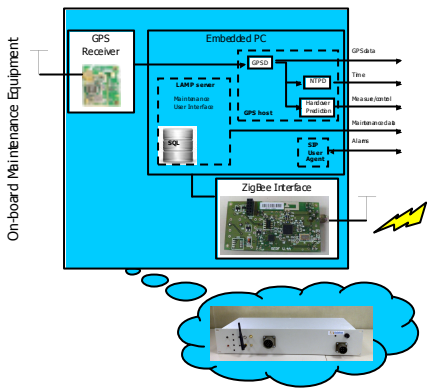
Data Supervisor activity diagram



Data Supervisor practical exchanges process

Role of maintenance board and introduction of GPS handover prediction

- Maintenance board



- The GPS host provides GPS data and time synchronization through the ntpd and gpsd daemons and it's useful for handover prediction
- The LAMP server stores and serves maintenance data
- The wireless sensors detect events and the alarms are distributed via SIP protocol
- Maintenance events are received from BOSS cameras
- The maintenance staff accesses the information through a web interface
- Equipment ready for railway environment

- GPS handover prediction

The idea:
- The GPS based handover prediction system makes use of previously recorded access network properties (coverage, reliability, network addresses, etc.): it stores these properties with geographical information obtained from a GPS receiver.
- Since the train goes through the very same track every time, the same access network properties are expected along the same GPS coordinates.
- The system is thus able to predict handovers based on the GPS information.

As a consequence:
- The speed of the handovers is increased significantly.
- The probability of service outage in the access network is lower.
- The overall system performance is better.

The GPS based handover prediction module consists of two main components:
- The ANP module is directly connected to the GPS receiver, it maintains a location based database about measured radiolink parameters. Based on previously measured data set and recent position ANP provides predicted radiolink parameters for HM module.
- The HM module reads information from the physical cards and sends them to the ANP module (to store). The other way round, HM receives prediction information about future handovers, and thus it prepares the handover by setting up proper communication parameters.

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