

## Wireless Access Optimization for Future Networks

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### Wireless Access and the Future Internet

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- ▶ “Internet applications” and “Context awareness” are driving evolution of radio access networks
  - Mobile phones are permanent companions in everyday life
    - 1.2 billion mobiles sold per year
    - Mobile phones are equipped with physical sensors for light, temperature, velocity, acceleration, humidity, proximity, bar code and RFID reading, ... and location
  - “Internet of things” enabled by “trillions” of connected NEDs (mainly wireless connectivity)
  - Service requirements become more heterogeneous
    - From voice to live video streaming
  - Cost pressure

## Wireless Access and the Future Internet

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- ▶ Mobile services will drive expectations in Future Internet experience
  - Mobility
    - even in a very heterogeneous access landscape (GSM/GPRS, HSPA+, LTE, WiMax, ...)
  - Always and everywhere on
  - Roaming
  - Personal companion for everybody
  
- ▶ Flexibility and cost advantage of wireless technologies
  - Integration of sensor networks
  - M2M, robotics, smart factories, medical equipment, car-to-car communication
  
- ▶ Can a Future Internet provide the same functionality more efficiently?
  - IEEE 802.16 tried it and failed.



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## Wireless Access and the Future Internet

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Convergence of  
Radio Access Network evolution and wireless access to the future internet

- ▶ Functionalities to be addressed:
  - Mobility support (v&h)
  - Radio resource management (v&h)
  - Network Management
  - QoE, QoS management
  - Integration of M2M and sensor networks
  - Migration path
  
- ▶ Ideas investigated in Kaiserslautern (Schotten)
  - Framework for functional modules (e.g., parts of standards) in three dimensions (data, control, and management plane)
  - Context awareness for new services and access control (intelligent access)
  - System and service aware protocol selection

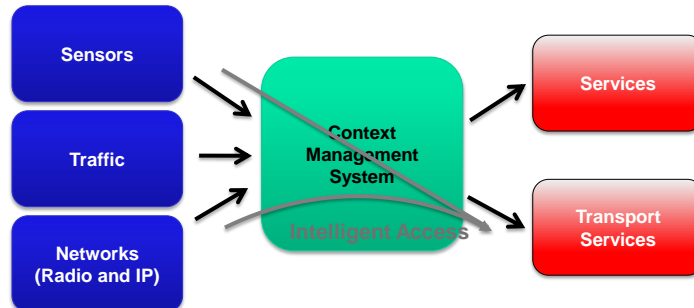


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## Ongoing Work in ASP3 (Kaiserslautern)

- ▶ Concept development
  - Identify Radio Access Network functionality that can be skipped
    - Mobility support can be significantly simplified
    - IP & radio multicasting
    - Use of network and traffic information for radio network control
      - Context Management System with open interfaces

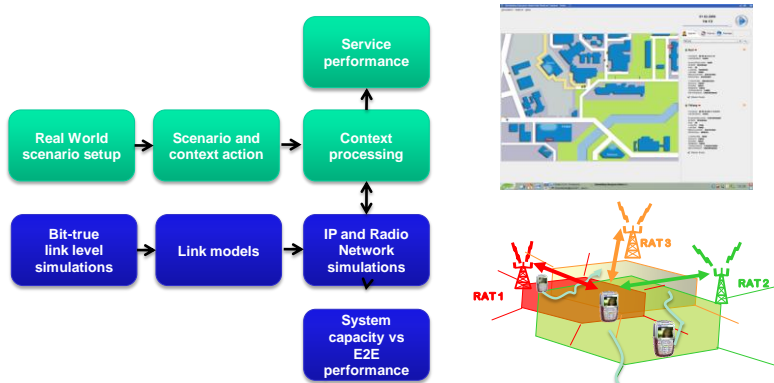


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## Ongoing Work in ASP3 (Kaiserslautern)

- ▶ Simulator Development
  - Methodology for evaluation of cross-domain QoE (internet & radio access)
  - Methodology for evaluation of real world internet scenarios

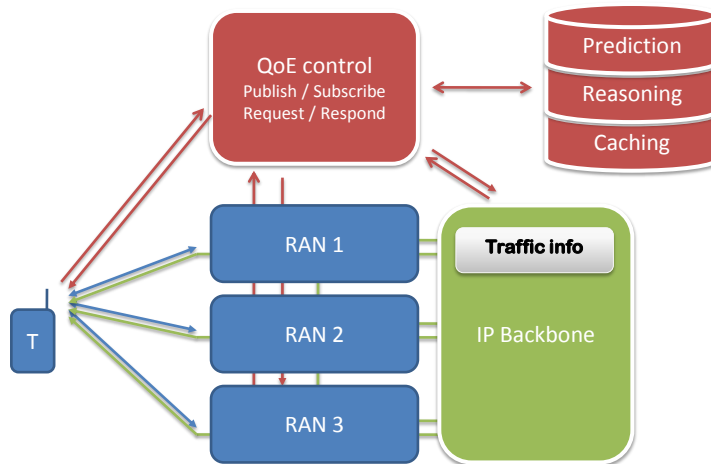


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## Ongoing Work in ASP3 (Kaiserslautern)

### ► Experimental Setup



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## Topics at University of Würzburg

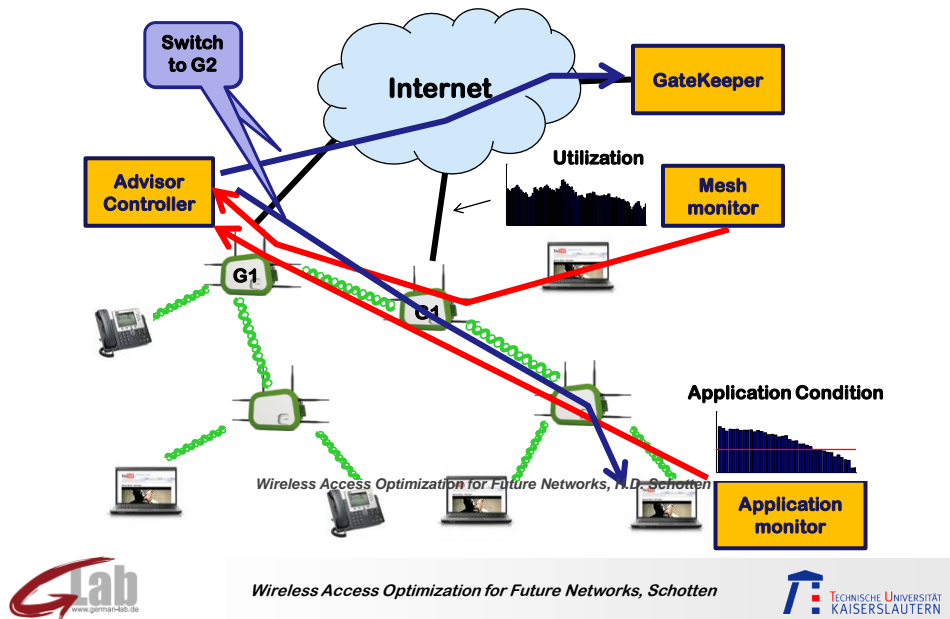
- Dynamic Gateway Selection in Wireless Mesh Networks (WMNs)
  - Technical solution
  - Intelligence
- Radio Resource Management (RRM) in WMNs
  - Congestion Control
  - Fairness
- Application Layer Performance Monitoring
  - Continuously observe the application condition
  - Install monitoring tool at the client
- Intelligent Application Layer Aware RRM in WMNs
  - gateway selection, congestion control, fairness, routing, channel allocation, scheduling, etc.



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## Vision



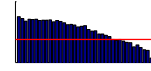
## Status

- ▶ Application Layer Performance Monitoring
  - QoS of VoIP connections
  - Buffered playtime of Flash Video Streaming  
→Demo:YouTube
  
- ▶ Dynamic Gateway Selection
  - Solution space established
  
- ▶ Congestion Control
  - Simulation study on IEEE 802.11s Intra-Mesh Congestion Control
  - Implementation of Traffic Controller on Mesh-Nodes (previous to G-Lab)

# Flash Video Monitoring

- ▶ Flash Video (FLV):
  - Video streaming over HTTP/TCP
  - Progressive download: Video starts playing while downloading over TCP
- ▶ Application condition:
  - remaining video play time buffered at client
- ▶ Monitoring:
  - Capture TCP packets
  - Detection of FLV downloads:
    - Scan for FLV metadata in first packet of TPC con
  - Estimation of remaining play time
    - detect tags in FLV stream
    - Tag states when a frame is played
  - Open problems
    - Estimation of video starting time
    - Jumps in the video

Application Condition



Application monitor

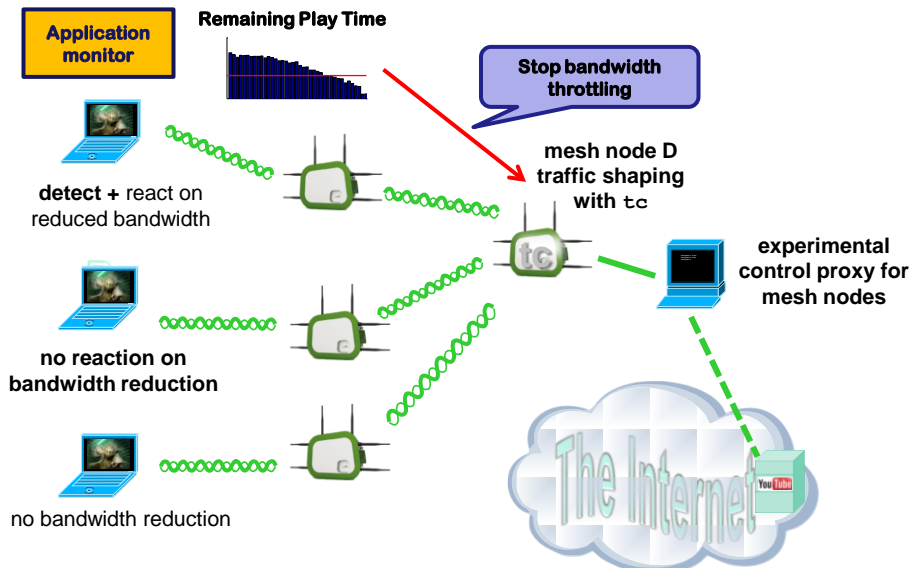
FLV file body



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# Demo: YouTube Monitoring



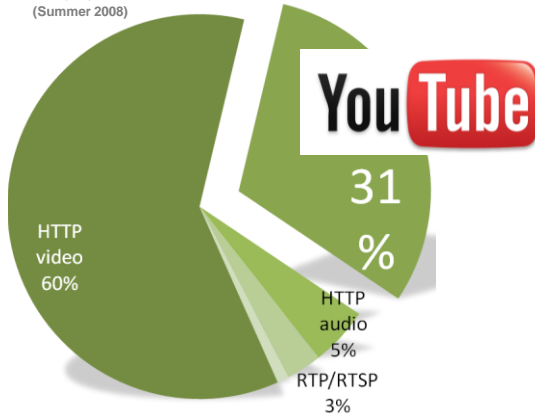
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## Why YouTube

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Streaming traffic  
in a broadband  
wireless access  
network  
(Summer 2008)



- ▶ YouTube technology
  - flash videos
  - progressive download
  - widely spread
- ▶ good starting point for application layer performance monitoring (ALP)



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