COURSE PROJECTS A.A. 2016/2017

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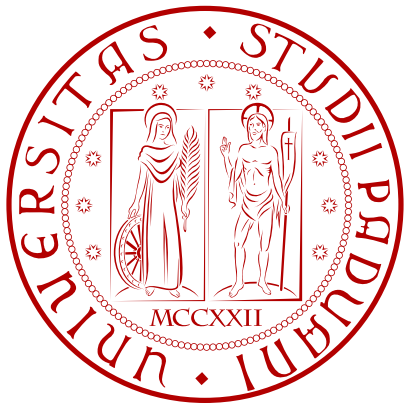


Approach

Groups

- A project for each group
- Group size: ≤ 3 (max.) people

Project types

T1) Technical Work
T2) State of the Art
T3) Exp. Project or contest

Style: Times New Roman 12 points, line inter-space 1 ½

Page budget (overall written project):

- min. 5 pages
- max. 15 pages

Final grade

$$G_{\mathrm{final}} = w_{\mathrm{w-ex}} G_{\mathrm{w-ex}} + w_{\mathrm{p}} G_{\mathrm{p}}$$

written examination **project**

Type 1 and 2 projects

$$\begin{cases} w_{\mathrm{w-ex}} = 0.6 \\ w_{\mathrm{p}} = 0.4 \end{cases}$$

Type 3 projects

$$\begin{cases} w_{\mathrm{w-ex}} = 0.4 \\ w_{\mathrm{p}} = 0.6 \end{cases}$$

Project structure

Technical work (15 pages overall)

Sect 1. Abstract (max. 10 lines)
Sect 2. Introduction (max. 1 page)
Sect 3. Technical Approach
Sect 4. Results (min. 7 pages)
Sect 5. Conclusions (max. ½ page)
Sect 6. References (usually between 3 to 15 refs)

Section 3: "Technical Approach"

Organized as detailed below

3.1 Objectives (max. 5 lines)
(*what you want to show*)

3.2 Diagram/Scenario (max. 20 lines)

3.3 Mathematical models used
(*channel, error rate, coding, needed Eqs., etc.*)

3.4 Complications found (max. 5 lines)

Section 5: “Conclusions”

(max. ½ pages short and focused)

Obj. 1) Summarize what you did in the project:

- modified an existing simulator;
- included support for, e.g., SACK ACKs;
- added module for, e.g., fading;
- performance metrics/analysis, etc.

Obj. 2) Lesson(s) learned

- a new programming language;
- writing a simulator;
- how to carry out a performance evaluation;
- behavior/performance of a protocol, …

Project Structure

State of the Art (15 pages overall)

Sect 1. Summary (max. 10 lines)

Sect 2. Introduction (max. 1 page)

Sect 3. Literature review:

takes up all the remaining available space considering that the max. length of the doc. is 15 pages

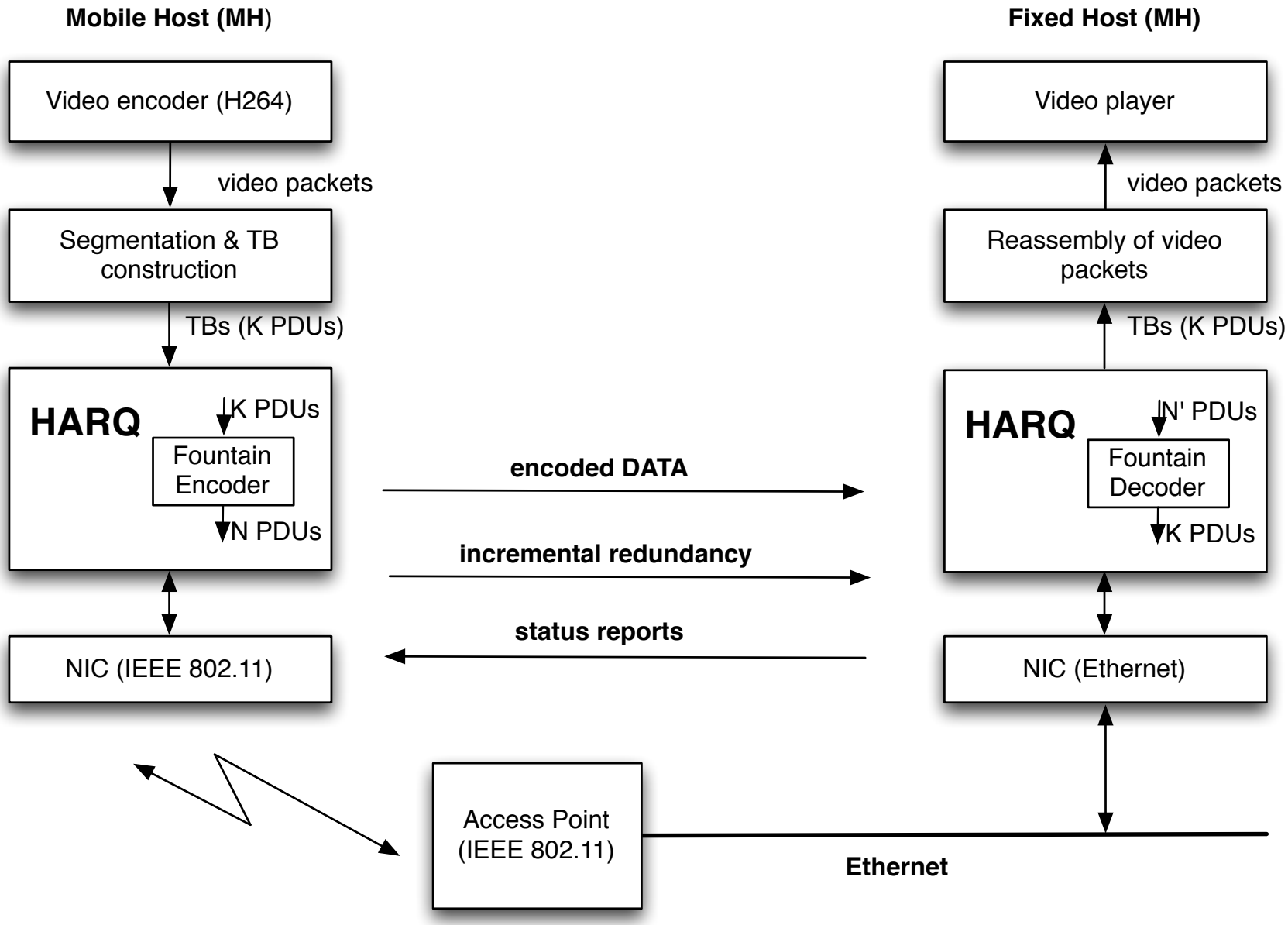
Sect 4. Conclusions (max. ½ page)

Sect 5. References (usually between 3 to 15 refs)

Number of References

- There is no min / max
- Usually a good number is between 3 and 15

T3 Project Example



T1 & T2 Projects

- A few proposals from me follow
  - 8 technical projects (P1-P8)
- Further topics are possible and MUST be discussed / agreed upon with the lecturer

P1) Simulation of Multipath Fading Channels

Approaches

- Jakes simulator: implementation
- Alternative approaches based on $F[g(t,\tau)]$

Project objectives

- Code selected approached with Matlab
- Test accuracy with respect to Rayleigh fading statistics
- Simulate multiple independent fading channels
- Simulate Rician fading channel

P1) References

Jakes simulator improvements:

[1] M. F. Pop and N. C. Beaulieu, Limitations of Sum-of-Sinusoids Fading Channel Simulators, IEEE Transactions on Communications, Vol. 49, No. 4, April 2001.

[2] C. Xiao, Y. R. Zheng, Simulation models with correct statistical properties for Rayleigh fading channels, IEEE Transactions on Communications, Vol. 51, No. 6, June 2003.

[3] C. Komninakis, A Fast and Accurate Rayleigh Fading Simulator, IEEE GLOBECOM, San Francisco, CA, US, 2003.

Simulation of Rician fading channels:

[1] C. Xiao, Y. R. Zheng, and N. C. Beaulieu, Novel Sum-of-Sinusoids Simulation Models for Rayleigh and Rician Fading Channels, IEEE Transactions on Wireless Communications, Vol. 5, No. 12, December 2006.

Parallel simulation of independent fading channels:

[1] Y. Li and X. Huang, The Simulation of Independent Rayleigh Faders, IEEE Transactions on Communications, Vol. 50, No. 9, September 2002.

[2] C. Xiao, Y. R. Zheng, Improved model for the simulation of multiple uncorrelated Rayleigh fading waveforms, IEEE Communications Letters, Vol. 6, No. 6, August 2002.

P2) Markov Fading Channels

Approaches

- Review of several techniques
  - Mathematical analysis
- Code selected approached with Matlab
- Check their comparative performance
  - First order statistics (e.g., Rayleigh pdf)
  - AutoCorrelation Function (ACF)
  - Accuracy *vs* number of states (e.g., wrt Rayleigh fading)

P2) References

[1] H. S. Wang, N. Moayeri, Finite-State Markov Channel - A useful model for Radio Communication, IEEE Transactions on vehicular Technology, vol. 44, n. 1, February 1995. (1D)

[2] Q. Zhang, S. A. Kassam, Finite-State Markov model for Rayleigh Fading Channels, IEEE Transactions on Communications, vol. 47, n. 11, November 1999. (1D)

[3] J. G. Ruiz, B. Soret, M. C. Aguayo-Torres, J. T. Entrambasaguas, On Finite State Markov Chains for Rayleigh channel modeling, Wireless Communication, Vehicular Technology, Information Theory and Aerospace & Electronic Systems Technology, 2009. Wireless VITAE 2009. (1D)

[4] J. M. Park, G.U. Hwang, Mathematical Modeling of Rayleigh fading channels based on finite state Markov Chains, IEEE Communications Letters, vol. 13, n.10, October 2009. (1D)

[5] P. Bergamo, D. Maniezzo, A. Giovanardi, G. Mazzini, M. Zorzi, An improved Markov Chain description for fading processes, IEEE International Conference on Communications, vol. 3, 2002. (2D)

[6] R. Carruthers, N. C. Beaulieu, On an improved Markov Chain model of the Rayleigh fading channel, Proc. IEEE Globecom 2007, 2007. (2D)

[7] R. Carruthers, N. C. Beaulieu, A quadrature Markov Chain model of the Rayleigh fading channel, IEEE International Conference on Communications, 2008. (2D)

P3) HARQ for Erasure Multicast Channels

Objectives

- Throughput performance,
- Delay performance,
- Scaling laws (increasing no. of receivers)

P3) References

[1] C. Huitema, The case for packet-based FEC, International Workshop on Protocols for High Speed Networks, 1996.

[2] J. Nonnenmacher, E. Biersack, D. Towsley, Parity-based loss recovery for reliable multicast transmission, IEEE Transactions on Networking, 1998.

[3] A. J. McAuley, Reliable broadband communications using a burst erasure correcting code, in Proc. ACM SIGCOMM, Philadelphia, PA, US, September 1990.

[4] J. Nonnenmacher and E. W. Biersack, The impact of routing on multicast error recovery, Comput. Commun., vol. 21, no. 10, pp. 867-879, July 1998.

[5] L. Rizzo, L. Vicisano, RMDP: an FEC-based reliable multicast protocol for wireless environments, ACM Mobile Computing and Communications Review, 1998.

[6] J. Wang, S. Park, D.J. Love, M.D. Zoltowski, Throughput Delay Tradeoffs for Wireless Multicast Using HARQ Protocols, IEEE Transactions on Wireless, Vol. 58, No. 9, Sept. 2010.

P4) Fountain & Raptor Codes

Technical scenarios:

- medium (K about 100 packets) and
- large (i.e., K>1000 packets) files

Objectives

- Overhead, complexity (encoding, decoding)
- Decoding based on Gaussian elimination
- LT codes, Raptor Codes

[1] M. Luby, LT Codes, Proceedings of the 43rd Symposium on Foundations of Computer Science (FOCS), 2002.

[2] A. Shokrollahi, M. Luby, Raptor Codes, Foundations and Trends in Communications and Information Theory Vol. 6, Nos. 3–4, 2009, pp: 213–322.

P5) Unequal Error Protection (UEP)

- ALC: Application Layer Coding
- UEP: adjust the amount of redundancy according to
  - Importance of data
- Objectives:
  - Understand the method
  - Implement it in C/C++ (recommended)
  - Test it over faded wireless channels

[1] Shakeel Ahmad, Raouf Hamzaoui, Marwan Al-Akaidi, Unequal Error Protection using Fountain Codes with Applications to Video Communication, IEEE Transactions on Multimedia, Vol. 13, No. 1, 2011.

P6) Distributed Networked Storage

Technical work

- Study reference papers
- Implement the proposed algorithms
- Simulation results
  - Network size, network topology

[1] Y. Lin, B. Liang, B. Li, Data persistence in large-scale sensor networks with decentralized fountain codes, IEEE INFOCOM 2007.

[2] S. A. Aly, Z. Kong, E. Soljanin, Fountain codes based distributed storage algorithms for large-scale wireless sensor networks, IEEE IPSN 2008.

[3] S. K.-Filipovic, P. Spasojevic, E. Soljanin, Doped Fountain Coding for Minimum Delay Data Collection in Circular Networks, IEEE Journal on Selected Areas in Telecommunications, Vol. 17, No. 5, June 2009.

[4] Z. Kong, S.A. Aly, E. Sojanin, Decentralized coding algorithms for distributed storage in wireless sensor networks, IEEE Journal on Selected Areas in Telecommunications, Vol. 28, No. 2, June 2010.

P7) IEEE 802.11 new MAC Designs

Technical work

- Study reference paper [1]
- Implement the proposed algorithm
- Compare (simulation) against IEEE 802.11DCF
  - Network size (number of nodes), network topology

[1] J. M. Chang, Z. Abichar, A Medium Access Control Scheme for Wireless LANs with Constant-Time Contention, IEEE Transactions on Mobile Computing, vol. 10, no. 2, pp. 191-204, February 2011. (protocol)

[2] J. Galtier, Analysis and optimization of MAC with constant size congestion window for WLAN, International Conference on Systems and Networks Communications (ICSNC), Cap Esterel, France, August, 2007. (theory)

See also: https://hal.archives-ouvertes.fr/inria-00195965/document

P8) MAC Protocols for WSN

Simulation-based study (simulator):

- Implement a number of selected MAC protocols
- N transmitting nodes, all within coverage (single-hop)
- 1 base station (sink node)
- Queueing & packet arrival models at the nodes
- Channel model, collision model

Performance analysis:

- Throughput, delay (queueing, transmission and total)
- Collision probability
- Energy efficiency at the nodes
- Study these as a function of N

A review project is also possible: “Taxonomy of MAC designs for WSNs”.

P8) MAC Protocols for WSN

[1] BMAC: J. Polastre, J. Hill, D. Culler, “Versatile low power media access for wireless sensor networks,” ACM Sensys 2004.

[2] TRAMA: V. Rajendran, K. Obraczka,J.J. Garcia-Luna-Aceves, “Energy efficient collision-free medium access control for wireless sensor networks,” Wireless Networks, 2006.

[3] CMAC: S. Liu, K.W. Fan, P. Sinha, “CMAC: an energy efficient MAC layer protocol using convergent packet forwarding for wireless sensor networks,” ACM Transactions on Sensor Networks, 2009.

[4] Y. C. Tay, K. Jamieson, H. Balakrishnan, Collision Minimizing CSMA and its Application to Wireless Sensor Networks, IEEE Journal on Selected Areas in Communications, Vol. 22, No. 6, August 2004.

[5] Michele Rossi, Nicola Bui and Michele Zorzi, Cost and Collision Minimizing Forwarding Schemes for Wireless Sensor Networks: Design, Analysis and Experimental Validation, IEEE Transactions on Mobile Computing, Vol. 8, No. 3, March 2009, pp: 322-337.

Review: Distributed Compression Algorithms for WSNs

Review project

- Joint routing and data aggregation
- Spatio-temporal compression
  - Distributed Source Coding, Compressive Sensing, interpolation

Example papers

[1] G. Quer, R. Masiero, G. Pillonetto, M. Rossi and M. Zorzi, Sensing, Compression and Recovery for WSNs: Sparse Signal Modeling and Monitoring Framework, IEEE Transactions on Wireless Communications Vol. 11, No. 10, October 2012.

[2] M. Hooshmand, M. Rossi, D. Zordan, M. Zorzi, Covariogram-based Compressive Sensing for Environmental Wireless Sensor Networks, IEEE Sensors Journal, Vol. 16, No. 6, March 2016.

Review: Energy Harvesting WSNs

Review project

- Pick a topic
- Discuss selected papers

Example papers:

[1] N. Bui, M. Rossi, Staying Alive: System Design for Self-Sufficient Sensor Networks, ACM Transactions on Sensor Networks, Vol. 11, No. 3, March 2015.

[2] D. Zordan, T. Melodia and M. Rossi, On the Design of Temporal Compression Strategies for Energy Harvesting Sensor Networks, *IEEE Transactions on Wireless Communications*, Vol. 15, No. 2, February 2016.

Review: Cognitive Networking

Objective

- Review of CN solutions at the MAC and network layers and up (no PHY), e.g.,
  - Channel access (MAC)
  - Routing / data gathering in WSN
  - Service discovery
  - Radio access selection

Many papers available: accurate selection needed depending on topic

Project Due Date (PDD)

To pass the exam you need

- To pass a written exam
- To deliver your project

First session

23/01/2017 – 24/02/2017 (PDD: 19/02/2017)

Second session

12/06/2017 – 21/07/2017 (PDD: 27/06/2017)

Third session

21/08/2017 – 22/09/2017 (PDD: 12/09/2017)

Written Exam (WE) dates

First session

23rd of January 2017 – 24th of February 2017

- WE: 06/02/2017
- WE: 20/02/2017

Second session

12th of June 2017 – 21st of July 2017

- WE: 12/06/2017
- WE: 26/06/2017

Third session

21st of August 2017 – 22nd of September 2017

- WE: 11/09/2017

Question & Answers