UNIVERSITAT POLITÈCNICA DE VALÈNCIA
CAMPUS DE GANDIA

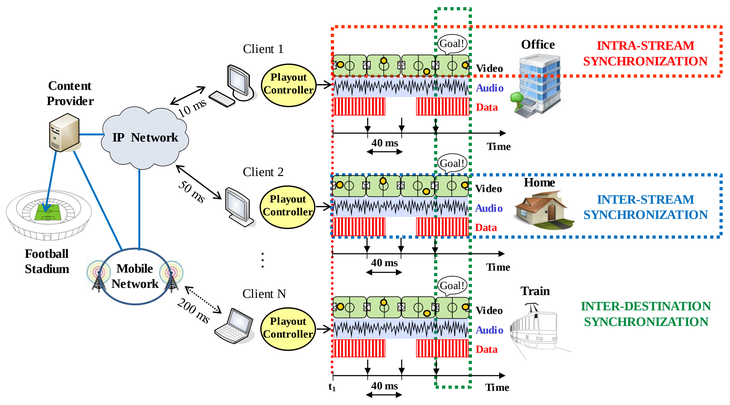
CWI

Design, Development and Evaluation of an Adaptive and Standardized RTP/RTCP-based IDMS Solution

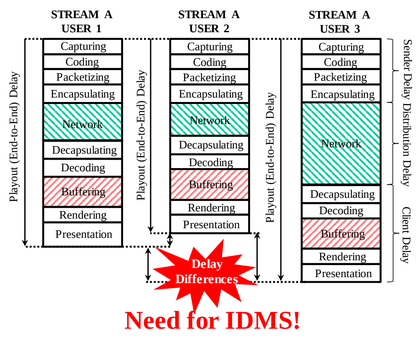
Mario Montagud Climent, mamontor@upv.es
Telecommunication PhD Program, Communications Department, Universitat Politècnica de València (UPV)
Supervisors: Prof. Fernando Boronat Seguí (UPV), Dr. Pablo Cesar (CWI)
CWI: The National Research Institute for Mathematics and Computer Science (Amsterdam, The Netherlands)

1. Introduction & Motivation

- **Motivation**: Increasing relevancy of shared media experiences → Networked togetherness around media content.
- **Definition:** Inter-Destination Media Synchronization (IDMS) refers to the simultaneous synchronization of the playout processes of a specific media stream across geographically distributed devices.



- **Main Challenge**: Delay Variability!

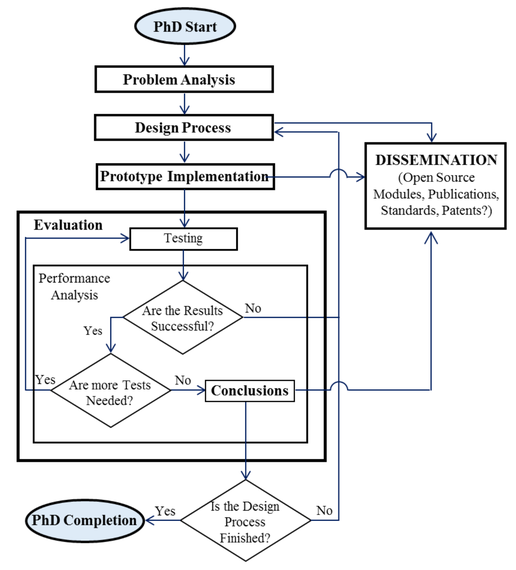


Need for IDMS!

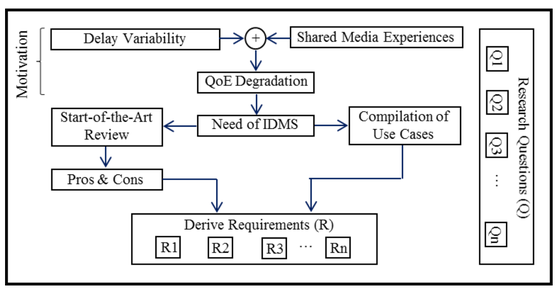
2. Use Cases

Sync Level	Approx. Technical Requirement	Relevant use cases
Very high	~ 10 µs – 10 ms	- **Networked stereo loudspeakers** - Phased array transducers - **Video walls**
High	~ 10 – 100 ms	- Distributed tele-orchestra - Networked quiz shows - **Networked real-time multiplayer games** - **Multi-party multimedia conferencing** - Conferencing sound reinforcement system - Game-show participation
Medium	~ 100 – 500 ms	- **Synchronous e-learning** - **Synchronous Groupware** - Presence based games - Consumer-originated content - **On-line election events** - Multi-screen sync
Low	~ 500 – 2000 ms	- Seamless switching among media devices - Shared service control - **Social TV**

3. Methodology

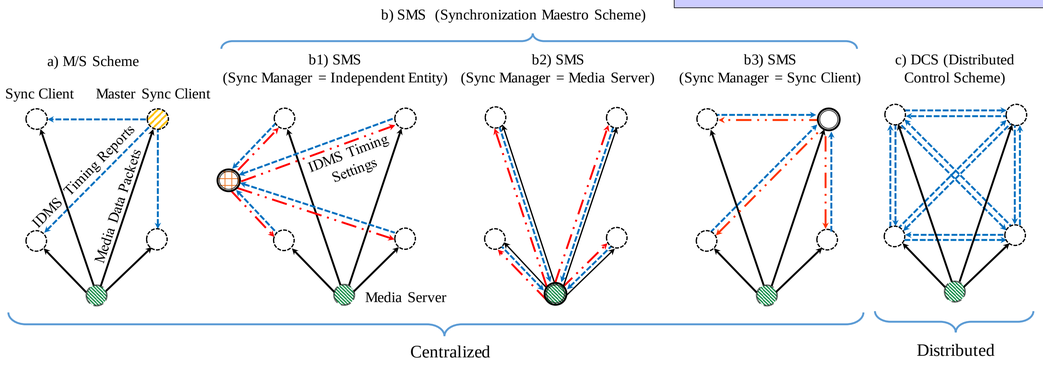


4. Problem Analysis



Why, When and How IDMS must be performed?

5. Architectural Approaches for IDMS



QUALITATIVE COMPARISON

		Factors									
		Robustness	**Scalability**	**Traffic Overhead**	**Interactivity**	**Consistency**	**Causality**	**Coherence**	**Flexibility**	**Fairness**	**Security**
Schemes	**M/S**	3	1	1	1	2	1	3	3	3	2
	DCS	1	2	3	2	3	3	2	1	1	3
	SMS	2	3	2	3	1	2	1	2	2	1

6. Requirements

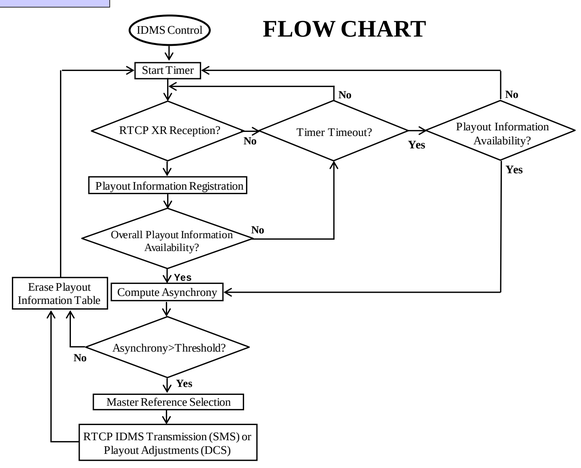
- Desirable resilience on standardized components.
- Low traffic overhead.
- Inter-operability and widespread support.
- Sync metadata in the media delivery units.
- Valid for different media streams and applications.
- Valid for stored and live streaming services.
- Resilience on wall-clock timing information.
- Compensation of the end-to-end delay.
- 64-bit timestamps
  - → Resolution in the order of µs
- Need for an adaptive and scalable feedback channel.
- Inherent rate adaptive techniques

7. Design Process

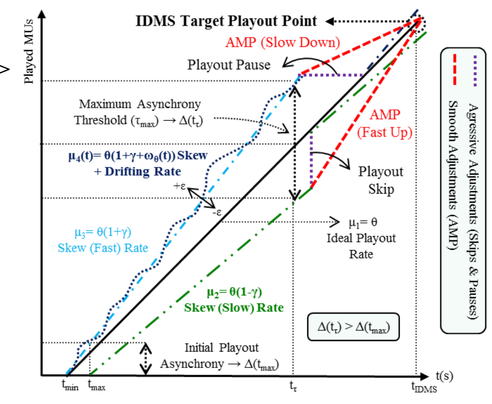
- **PROTOCOL SPECIFICATION** (IETF Standardization):
  - RTP for Media Delivery (Useful Metadata for IDMS)
  - RTCP Extensions for IDMS:
    - → Newly defined RTCP Packets and Reports.
    - → Early Event-Driven (EED) RTCP Feedback.
  - SDP Extensions to Inform about:
    - → The Usage of IDMS Messages and Group Membership.
    - → Bootstrap information (e.g., usage of Wall-Clock Sources).
  - Group-based IDMS (Concurrently sync of independent groups).

- **MASTER REFERENCE SELECTION POLICIES**:
  - Analysis of the suitability/feasibility of different dynamic policies for choosing the reference IDMS timing to synchronize with.
  - GOALS:
    - → Interactivity, efficiency, fairness, etc.
    - → Stability of the playout buffer occupancy.

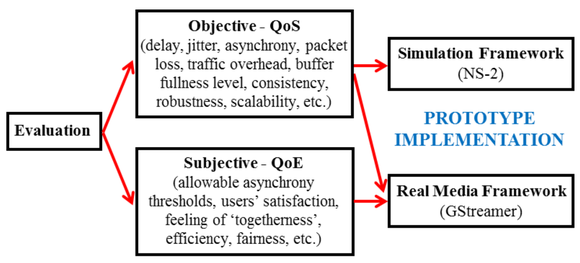
FLOW CHART



PLAYOUT ADJUSTMENT TECHNIQUES

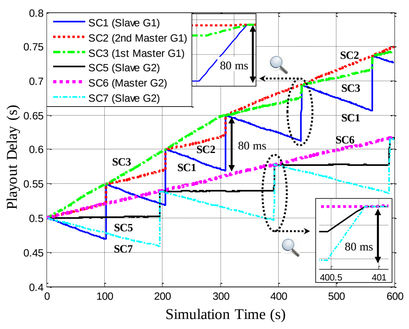


8. Evaluation Methodology

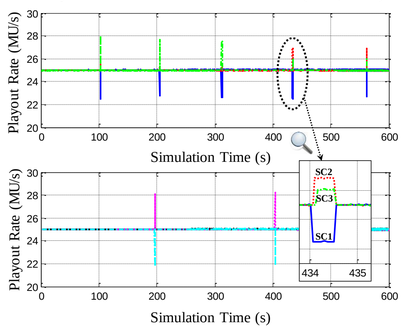


9. Some Results

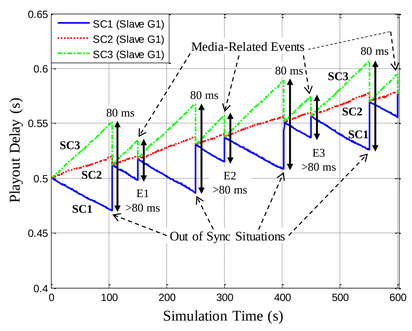
Group-based IDMS to the Slowest Sync Client (SMS, AMP)



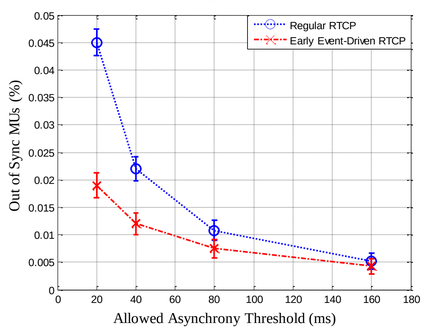
Playout Rate Variation to Achieve IDMS (SMS, AMP)



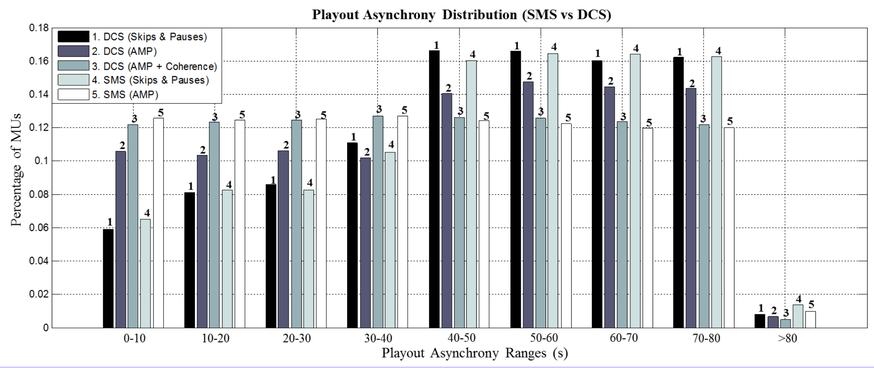
Early Event-Driven (EED) RTCP for IDMS (SMS)

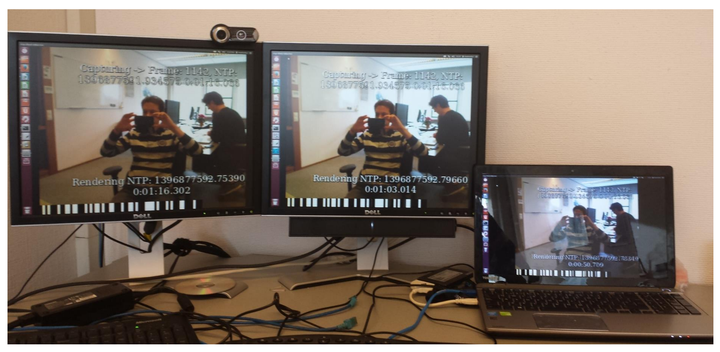


Interactivity Comparison (Regular vs EED RTCP for IDMS)



Playout Asynchrony Distribution (SMS vs DCS)





10. Publications

- 1 Internet Engineering Task Force (IETF) Standard.
- 5 papers in SCI-indexed journals (Computer Networks, Multimedia Systems, IEEE Communications Magazine and IEEE Communication Letters).
- 2 papers in other international journals
- 1 book chapter (Springer Editorial)
- 10 papers in relevant international conferences (e.g., ACM Multimedia, IEEE LCN, IEEE MASCOTS …)
- 3 papers in international workshops (MediaSync)
- 2 papers in national conferences (JITEL).
- 2 open-source modules.