Leveraging Transitions for the Upload of User-generated Mobile Video

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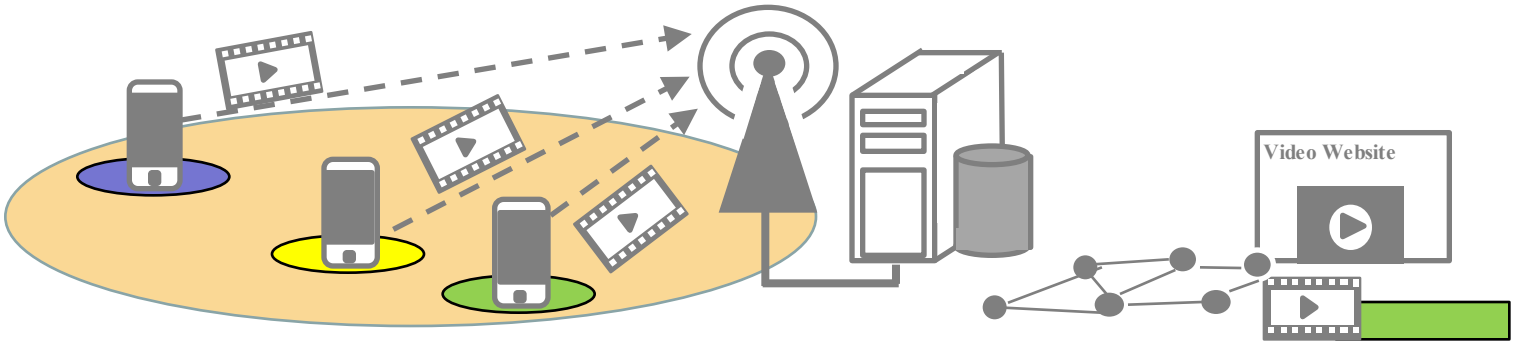
ACM Workshop on Mobile Video 2016 (MoVid)



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(Live) User-generated Video

Motivation

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User-generated video traffic is increasing

- YouTube accounts for 16.7% of aggregated traffic (peak times) [Sandvine2013]
- Mobile upload to YouTube accounts for 13.2% of the traffic [Sandvine2013]

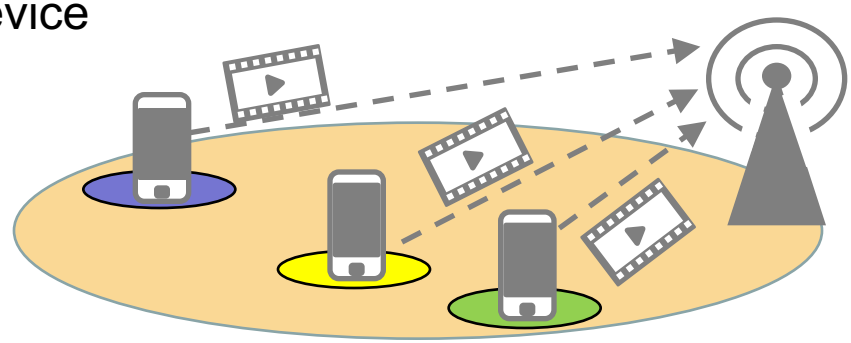
USTREAM

bambuser
Live from your mobile!

YOU NOW

Live video streaming services are on the rise

- Record video on mobile multi-purpose device
- Live streaming video to remote servers
- Mobile video upload vs. video streaming
  - **live** and **low delay**
  - **uplink** is limited



Scenario
Motivation

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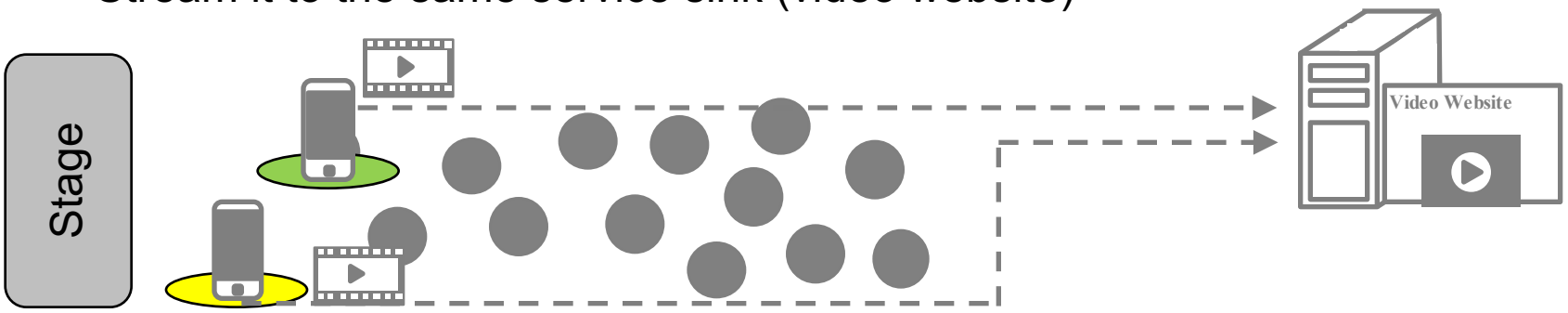
Mobile Broadcasting Services [3GPP]

- Near real-time (instant sharing) upload of any (multi)media
- One or multiple receivers
- Remote or in-situ streaming

Scenario: Videos at large-scale events

- Multiple streams are created at the same location – ideally in parallel
- Concurrency for limited uplink capacity, e.g., LTE
- Stream it to the same service sink (video website)



Goals of this Work

Goals

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Goals

- Assess the potential for transitions (adaptations) in the context of a MBS
- Leverage different upload mechanisms to achieve a superior streaming performance in comparison to a single-mechanism approach
- Evaluate the MBS under varying application needs (virtual director)

Network Transitions as …

- a complete replacement of a protocol during the runtime of an application [Froemmgen2015]
- Assumed variety of protocols exist …
  - which offer similar functionality, e.g., the uploading of video streams,
  - show different performance characteristics under different environmental conditions

Transition-capable Runtime for Video Upload

Design

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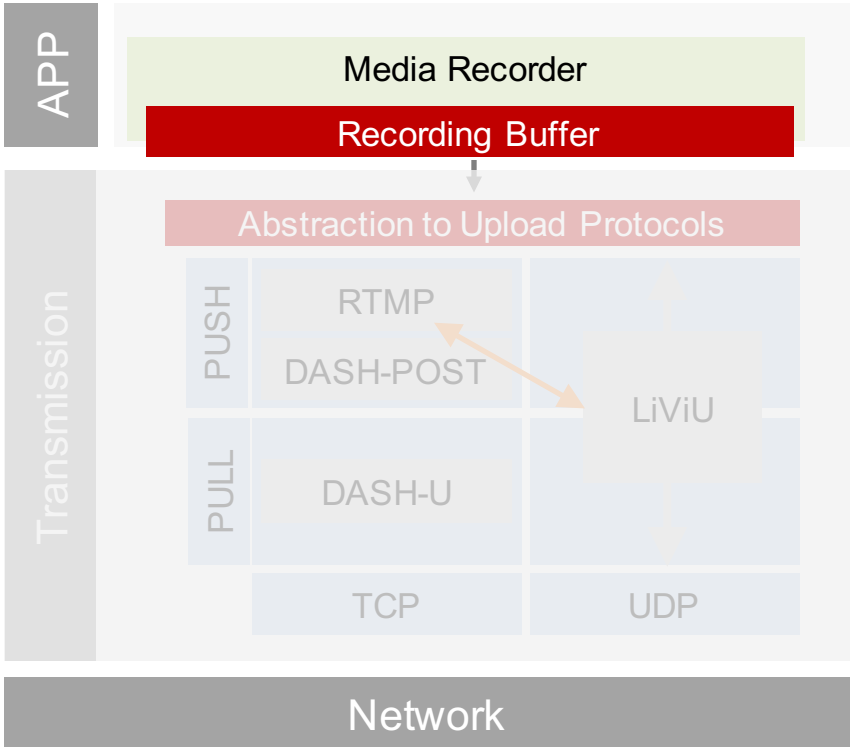
Runtime for Transitions

- Upload mechanisms are implemented on the application layer
- Abstraction to media recording device
  - Recording Buffer (keep as small as possible)
  - Network (Transport Layer and below)
    - Functionality for sending video segments in an IP-based network
    - Assumption: End-to-end connectivity



Upload Mechanisms (1/3)

Design

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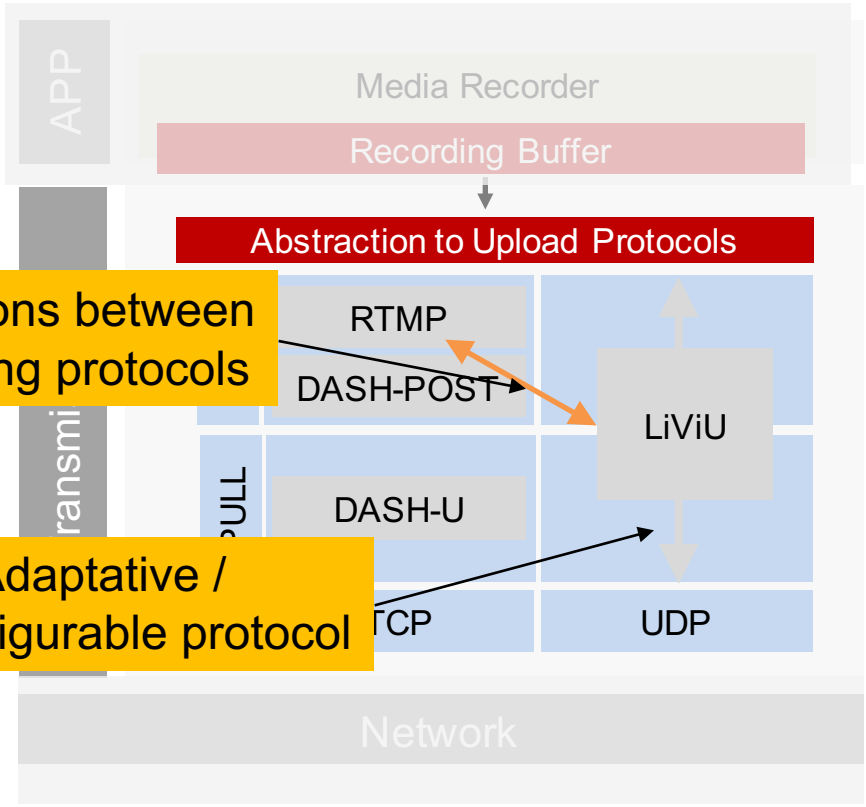
Upload Mechanisms

- RTMP – De-facto standard for MBS at the moment
- DASH-U – Concept of DASH mapped to the upload of video
- DASH-POST – HTTP-POST based media delivery as proposed by Seo et al. [Seo2012] and used by Meerkat
- LiViU – A custom, adaptive video uploading protocol



Upload Mechanisms (2/3)

Design

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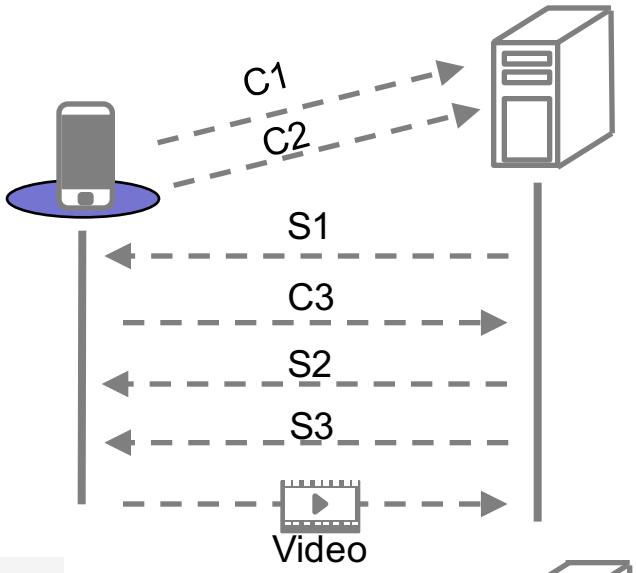
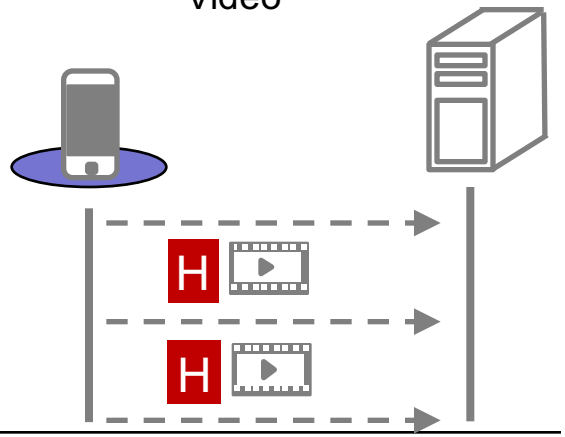
RTMP - Real Time Messaging Protocol [Adobe2009]

- Most used upload protocol in MBS: Bambuser, uStream, YouNow and Facebook Live
- Rather complex session management for media synchronization, joining procedure
- Overhead reduced header format
- TCP-based protocol
- Support for multiple qualities can be integrated



DASH-POST - Segmenting+HTTP-POST delivery [Seo12]

- HTTP POST messages used for media delivery
- Stateless initiation of new streaming session
- No manifest update, state management required
- Signaling of quality index needed
- (Used by Meerkat)



Upload Mechanisms (3/3)

Design

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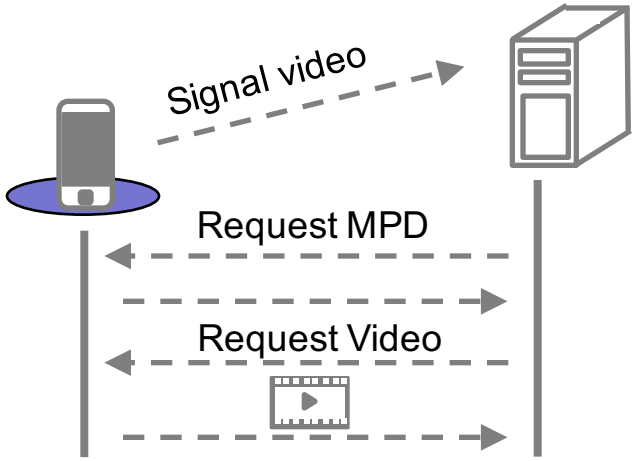
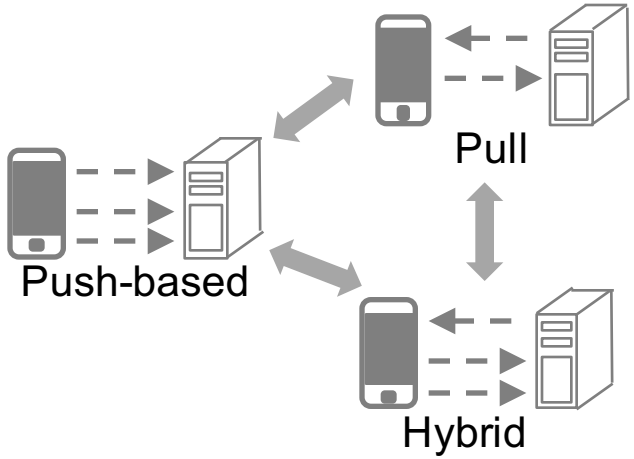
DASH-U – Upload of Video over DASH

- Video receiving server requests video segments using HTTP GET
- Server decides **when** to request **which** segment from **which** client
- Client signals manifest



LiViU – Live Video Upload

- UDP-based application layer upload protocol
- Adaptive protocol – can switch between …
  - Pulling video segments from mobile devices
  - Pushing video segments to the server
- Also used for the signaling of metrics necessary for transition decision making



Transition Decision

Design

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Metrics used for Transition Decision

- Protocol overhead (OH) [bits] - $OH = Traffic_{Session} - Traffic_{Video}$
- Goodput [bits/second] - $GP = Throughput - \frac{OH}{T_{session}}$
- Latency of a recording stream [ms] - $L = t_{rec\ l} - t_{rcv..rem.}$
- Join time of a session [ms]

Decision Making

- Idea is to optimize one of the metrics at a given time (minimize or maximize value)
- Application may decide to switch optimization goal
- Best protocol is determined every $T_{Transit}$ seconds

Evaluation Setup

Evaluation

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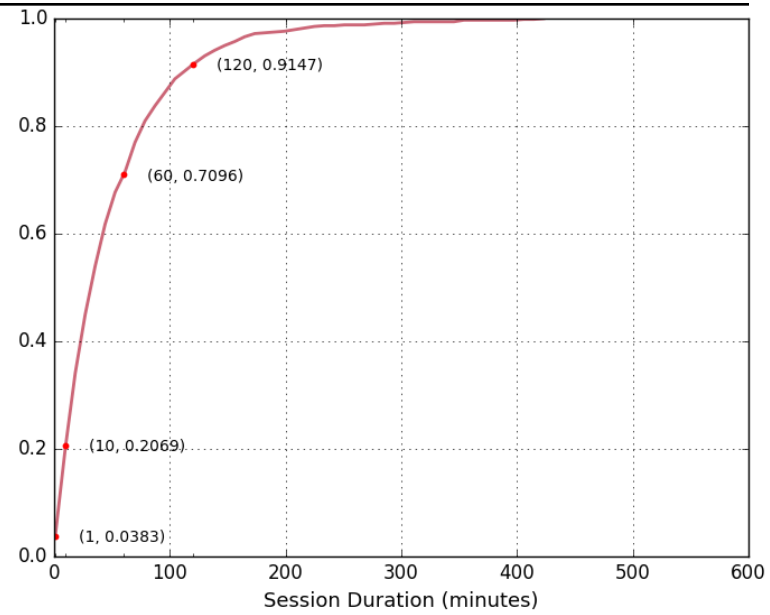
- **Simulation**: Simonstrator (NS3 communication models) [Ric2015]
- **Assess**: Transition metrics and average bitrate



Scenario 1: Concurrent Upload

- Concurrent upload with shared uplink capacity
  - Upload limited to 50 Mbit/s
  - End-to-end Latency between 100 – 300 ms
- Changing optimization goals over time

Nodes	Up to 1000 recorders (different events)
Bandwidth	LTE: up to 50 Mbit/s UL
Video	Segment length: 1s Rep.: 500, 750, 1000 kbit/s
Transition	Every 5 seconds

Evaluation Setup

Evaluation

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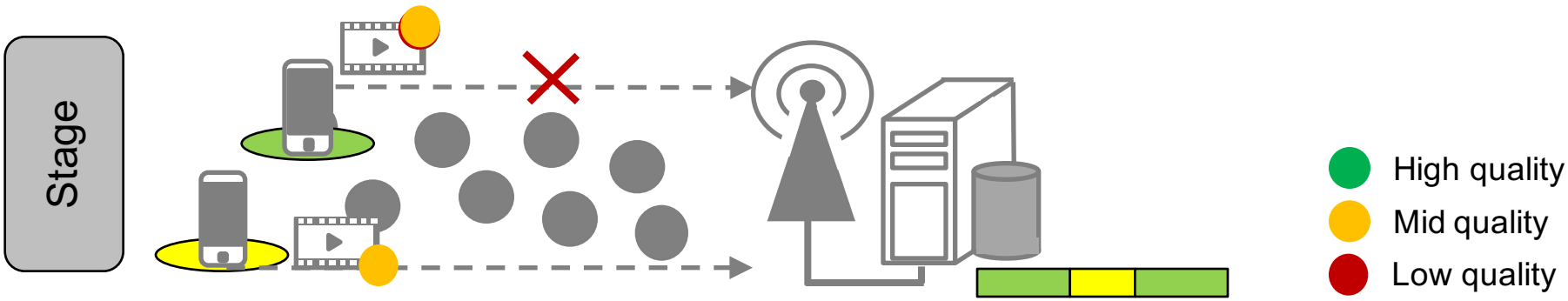
Scenario 2: Video Composition

- Extended version of a **quality-** and **diversity-driven** composition [Shrestha2010]
  - **Quality-driven**: At time t choose a video stream with the highest quality $Q_{max,t}$
  - **Diversity-driven**: Switch every t_{div} (genre-specific)
- Set optimization goals dynamically
  - Quality - **high**: goodput/ latency, **medium**: overhead, **low**: turn off transmission
  - State of a streaming session (transmission state and composition state) according the join time, goodput or latency



Evaluation Results (1/2)

Evaluation

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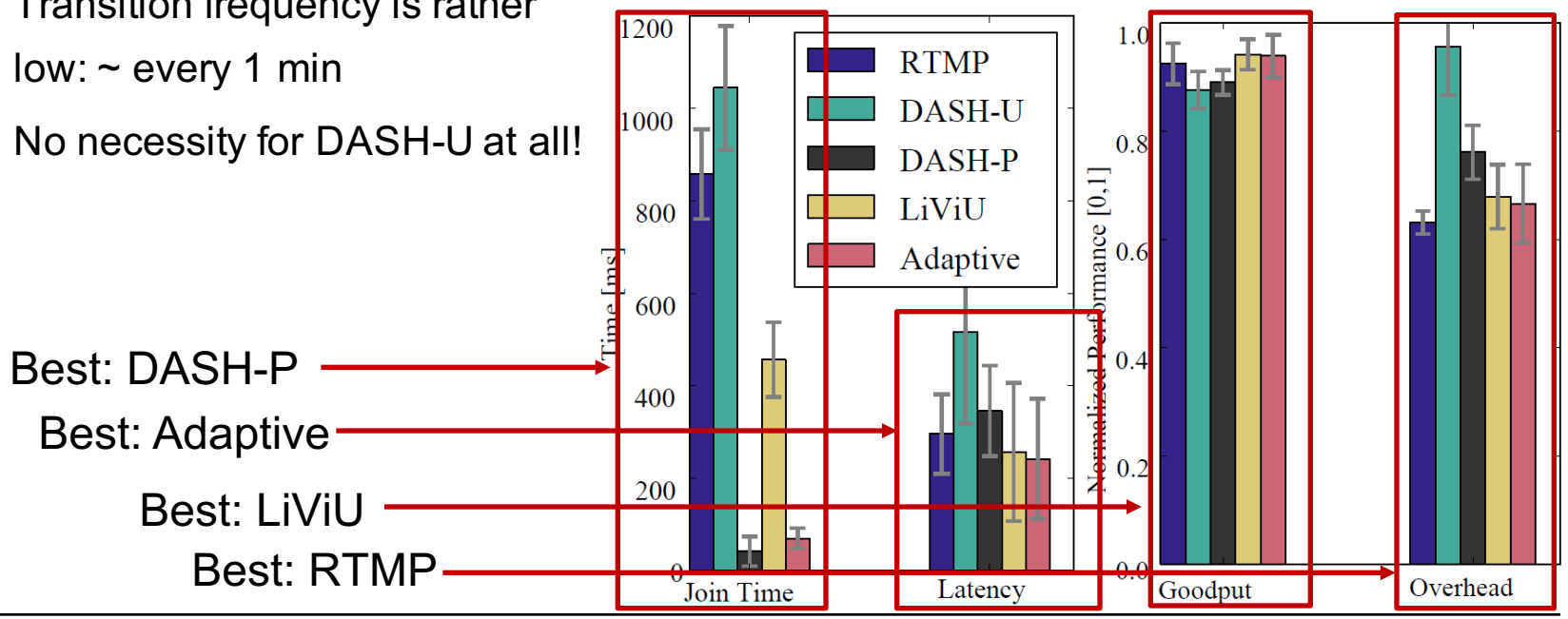
Flexibility of the Optimization

- **Scenario**: Concurrent – No „best“ upload protocol!
  - Using transitions between the protocols: „stuck in the middle“
  - Transitions as good method for benchmarking protocols in the wild
  - Transition frequency is rather low: ~ every 1 min
  - No necessity for DASH-U at all!



Evaluation Results (2/2)

Evaluation

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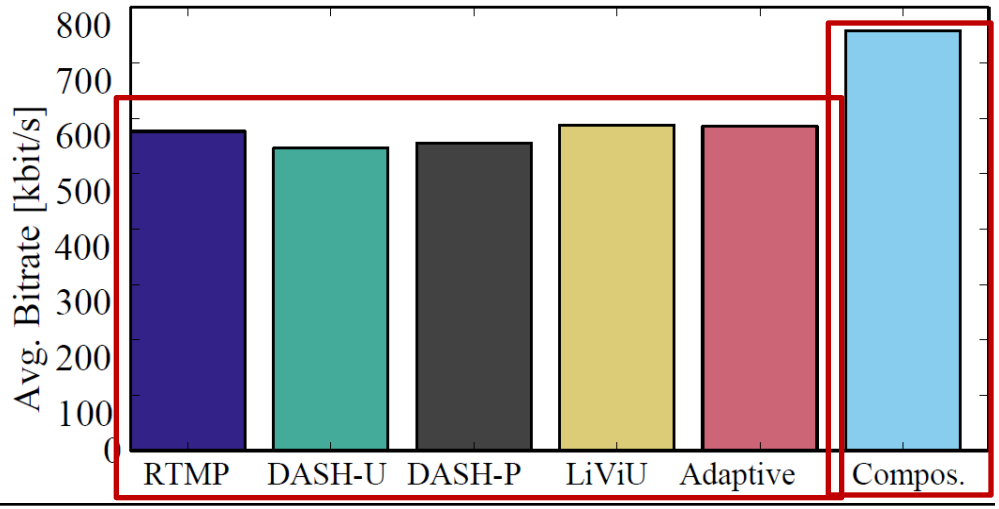
Achieved bitrates of the received video streams

- **Scenario**: Concurrent Upload

  Transition-capable bitrate is comparable (not significant higher) compared to the best, single protocol

- **Scenario**: Composition
  - DASH-U plays an important role: rapid request of video segments
  - Low quality streams are not transmitted, which increases the average bitrate



Conclusion and Outlook

Conclusion

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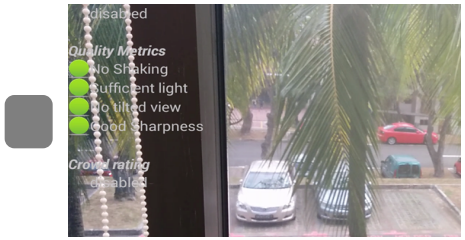
Conclusion

- Transitions are an adequate concept in MBS to integrate new protocols
- Allows to on-the-fly evaluate which protocols
- Successfully integrated the protocols …
  - DASH-POST – Push-based TCP video upload
  - DASH-U – Pull-based TCP video upload
  - RTMP – Push-based TCP streaming protocol
  - LiViU - Adaptive UDP-based streaming protocol
- **Missing:** quantitative evaluation of the costs of such a transition

Outlook

- Test it in the wild – Transition-capable prototype
- Learn from results and design superior hybrid protocol: LiViU+
- **But:** Keep capabilities for integrate new protocols



Thank you for your interest! Questions?

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User-generated Video
Motivation

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User-generated video traffic is increasing

- YouTube accounts for 16.7% of aggregated traffic (peak times) [Sandvine2013]
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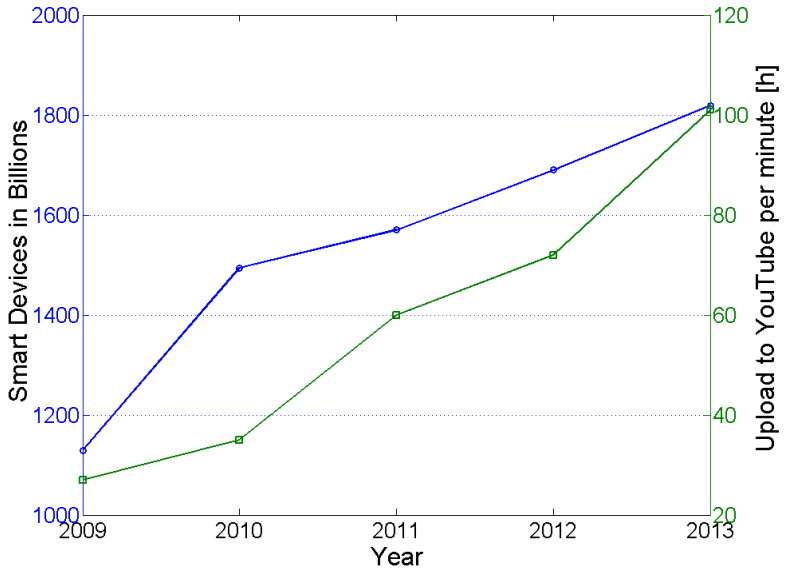
Smart devices are evolving

- Huge processing capabilities (multi-core)
- Ubiquituous access to the Internet
- Sensor-enabled
- Video recording capabilities



Based on: [Cisco2014], [YouTube2014]