Resilient Algorithms for Advance Bandwidth Reservation in Media Production Networks

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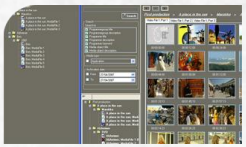
Multimedia production network

Central Production

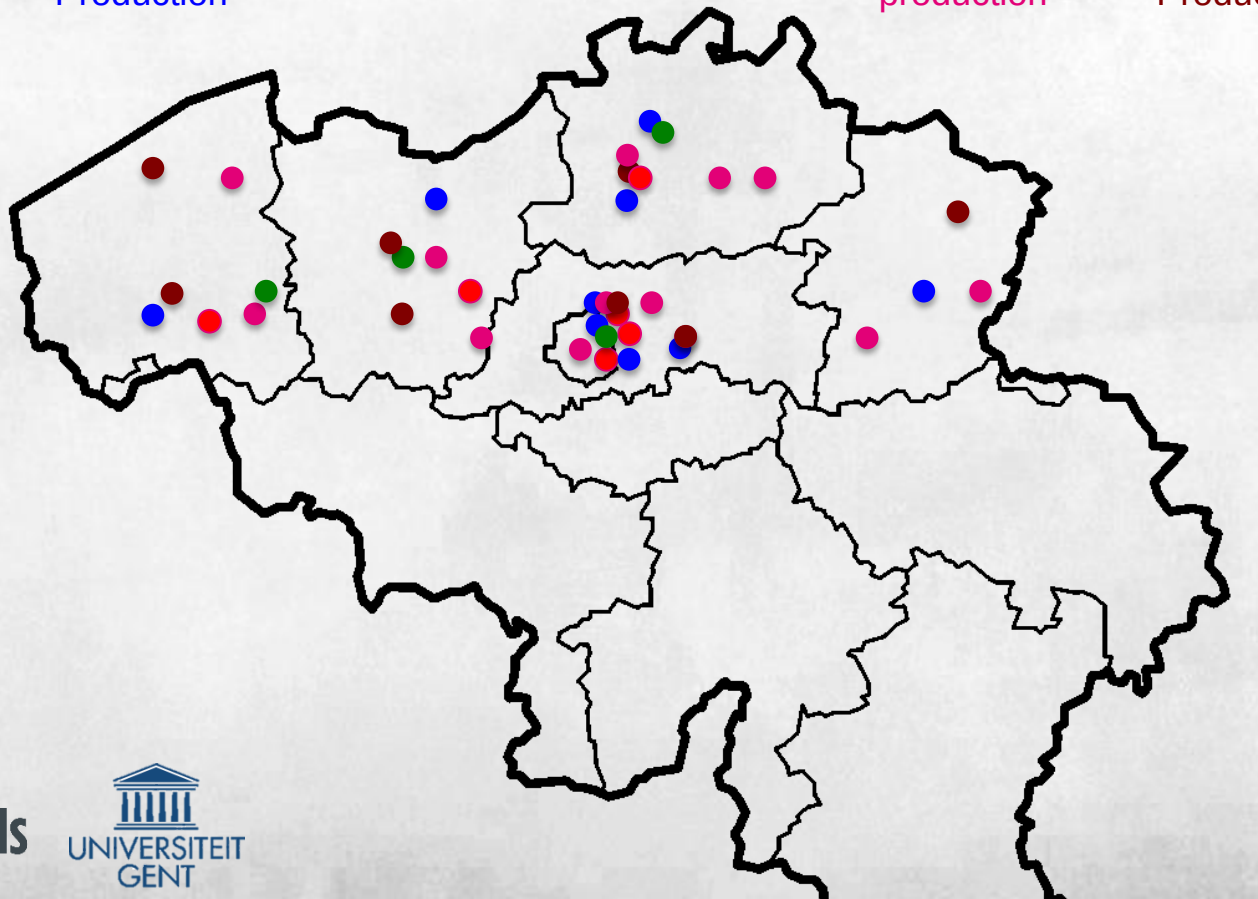
Broadcasting



Archiving

Post production

Remote Production



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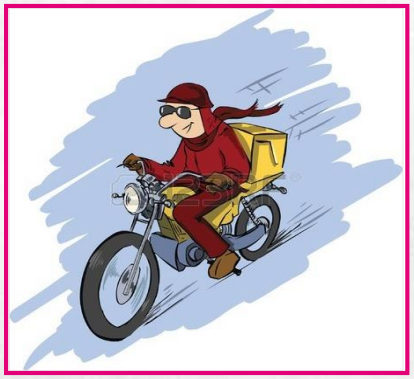
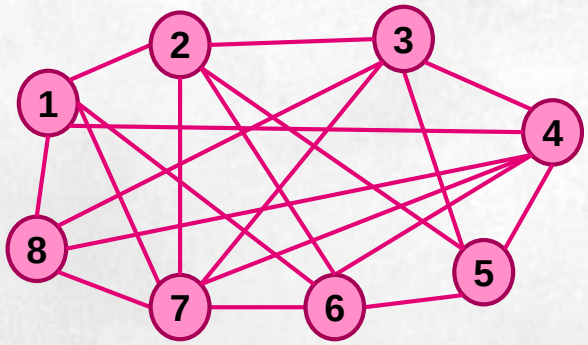
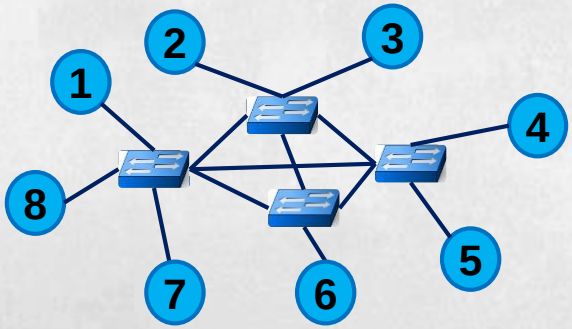
Challenge of distributing media files

- Traditional way of distributing media production content is highly inefficient (by hand, point-to-point optical links).





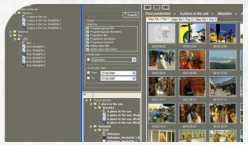
- Using a shared substrate network will increase network utilization and reduce the costs.



Our objective

Central Production

Broadcasting

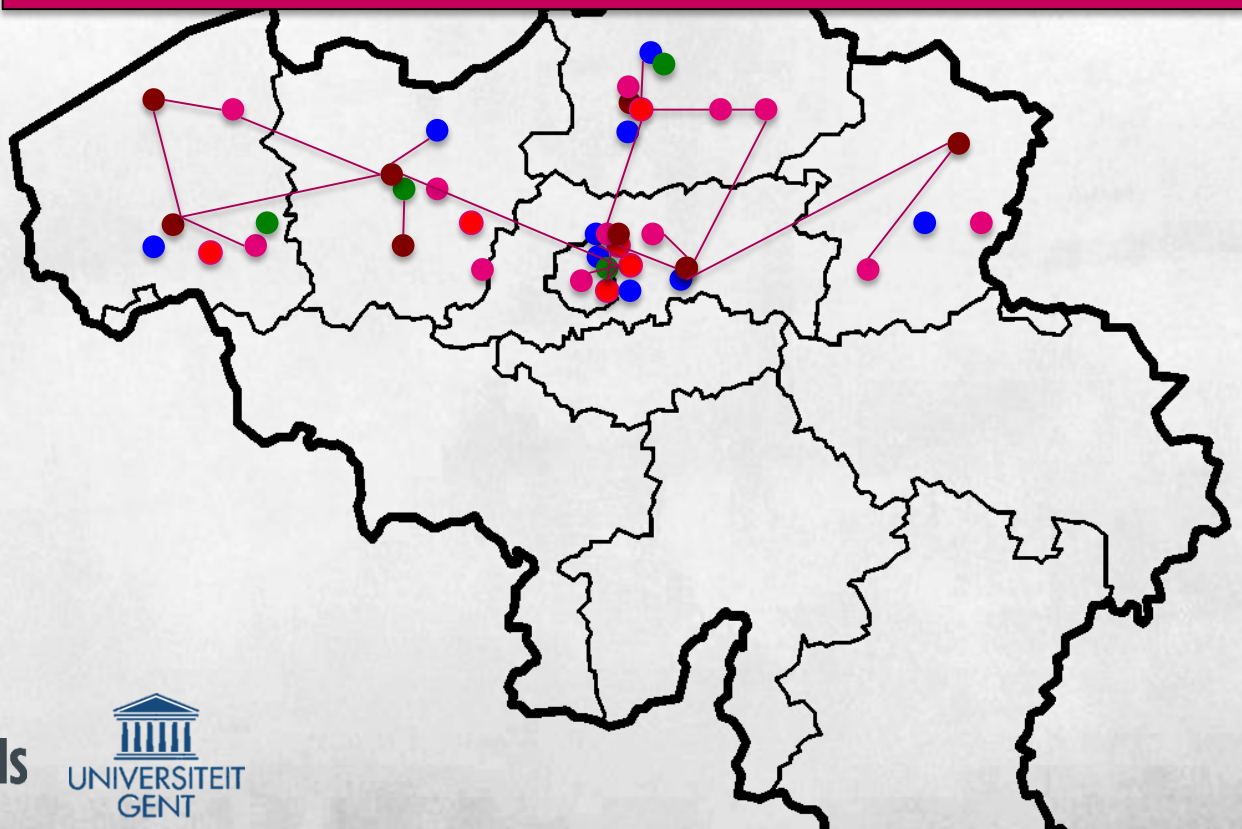


Archiving

Post production

Remote Production

Video Data Exchange over IP-based WAN



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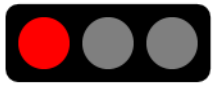
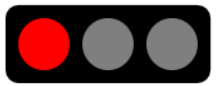
Requirements of Traffic Flows

Application	Bandwidth	Latency	Loss
Large file transfer			
High-res video (transfer)			
Random access video (editing)			
High-res video (streaming)			
Low-res video (streaming)			

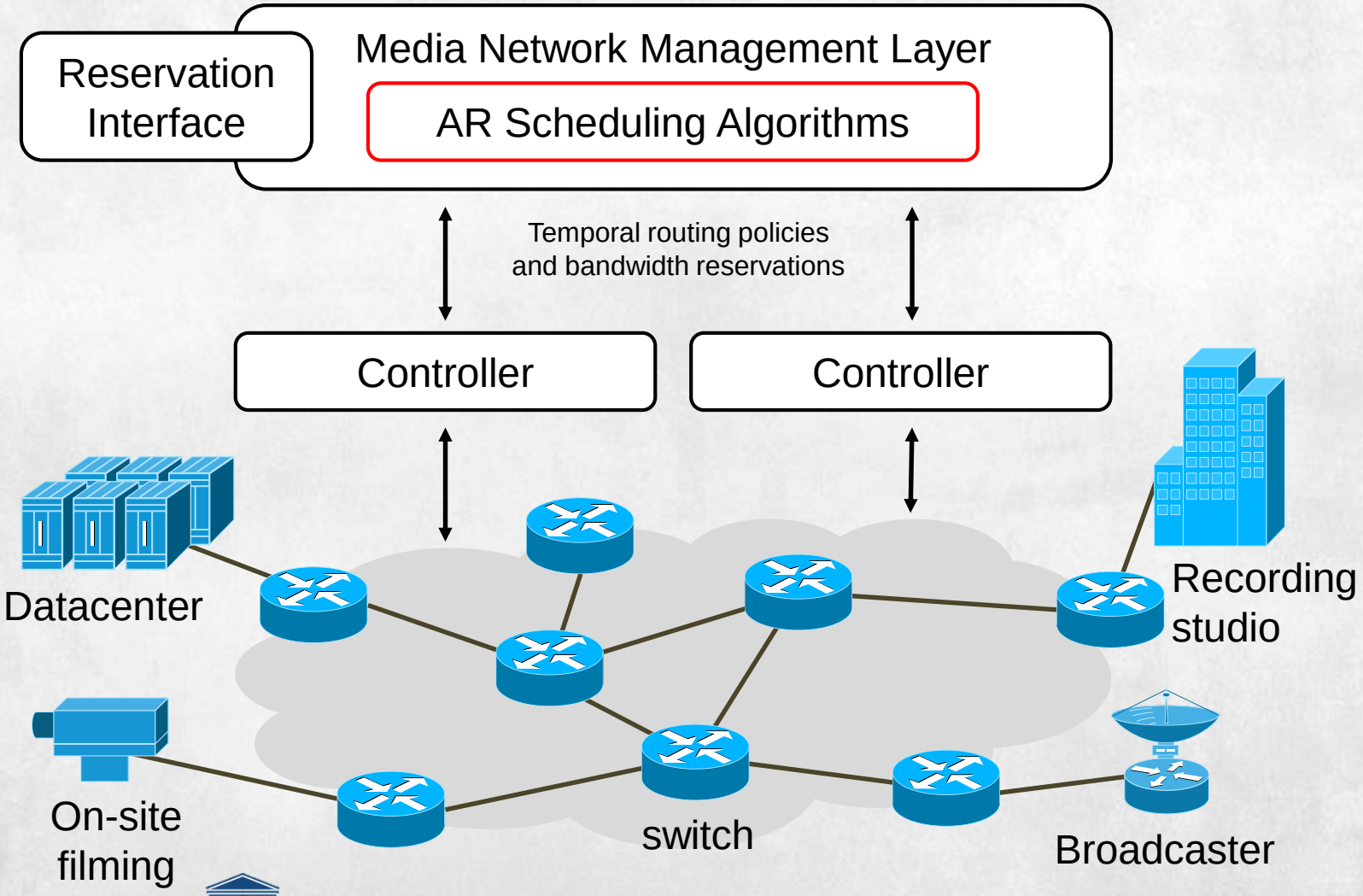
Characteristics of traffic flows

Request types	Specified start time	Specified duration	Dependent VS	Dependent FB	Independent VS	Independent FB
STSD	yes	yes			X	
STUD	yes	no				X
UTSD	no	yes	X			
UTUD	no	no		X		

Advance reservation

- Nature of traffic: predicable
- As traffic is predictable, Advance Reservation (AR) would result in great advantages.
- AR techniques: reserving the required amount of bandwidth over time

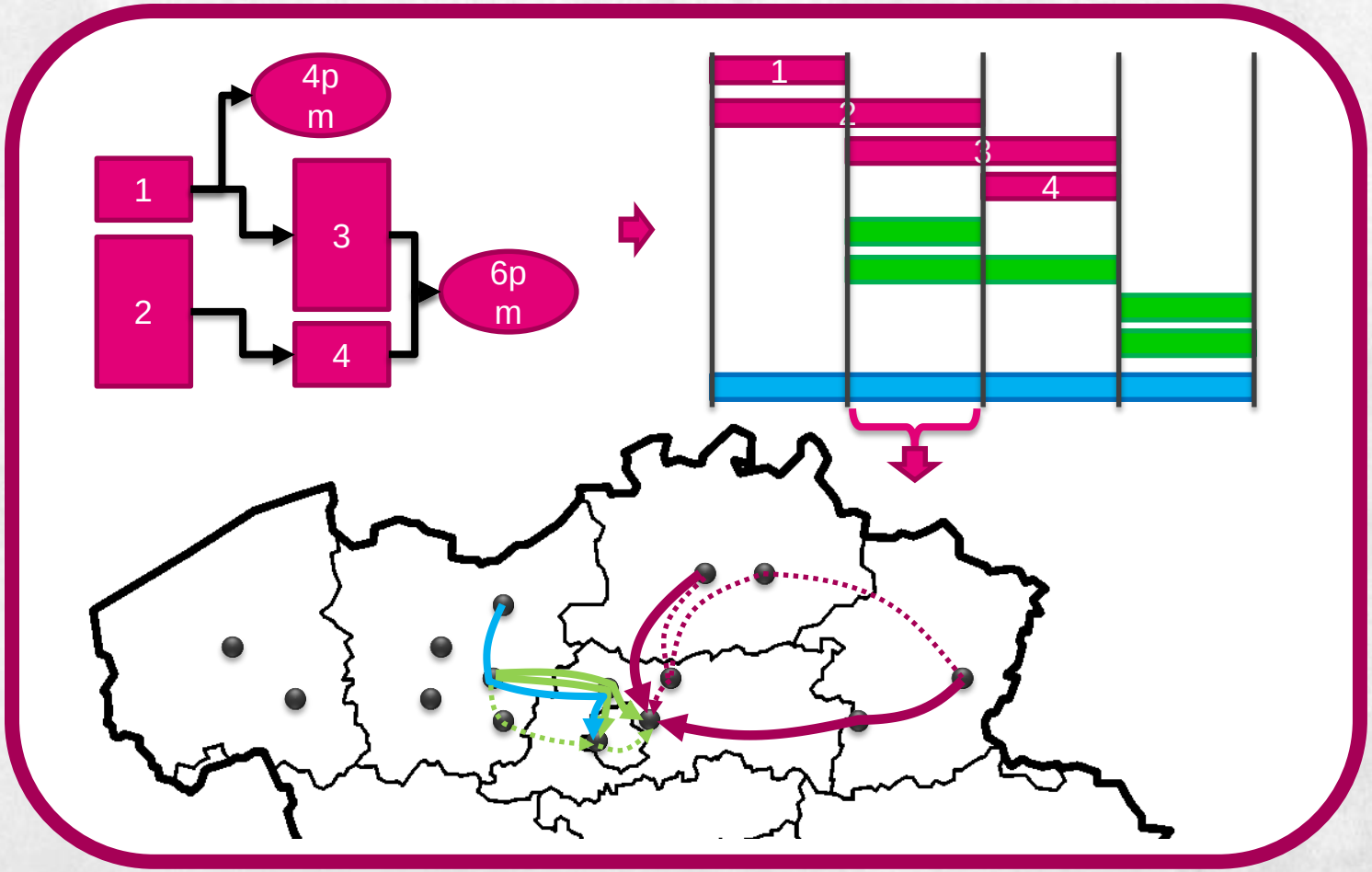
Contribution



Contribution

- Advance reservation approach supporting multipath routing
- Resiliency through protection mechanism
- Support of interdependency among requests
- Support of Video Streams (VS) and File Based transfers (FB)

Flexible/Fast Scheduling - Reservation



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Assumptions

1. File-based transfers & streaming sessions are supported.
2. Multiple requests may depend on each other.
3. For the FB:
   - The start time of requests is flexible.
   - The deadline is fixed.
   - The reserved BW may vary.
4. For the VS:
   - The start time/end time is fixed.
   - The reserved BW is fixed.

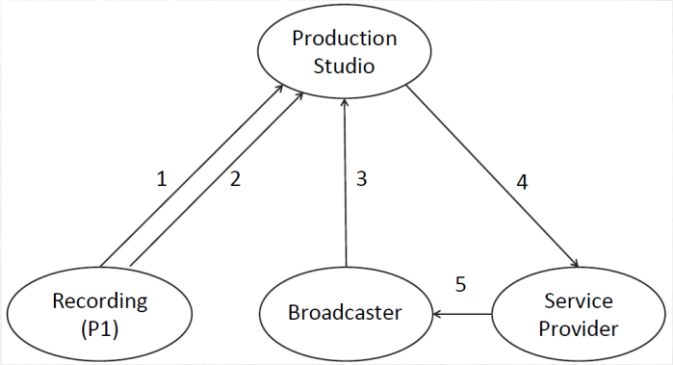
Objective

We aimed at:

1. Delivery of the requests before their deadline.
2. Maximizing the number of admitted requests.
3. Processing requests as quickly as possible.

Definitions

- ***Scenario***: contains a collection of interdependent file and video transfers. We refer to each transfer as request.

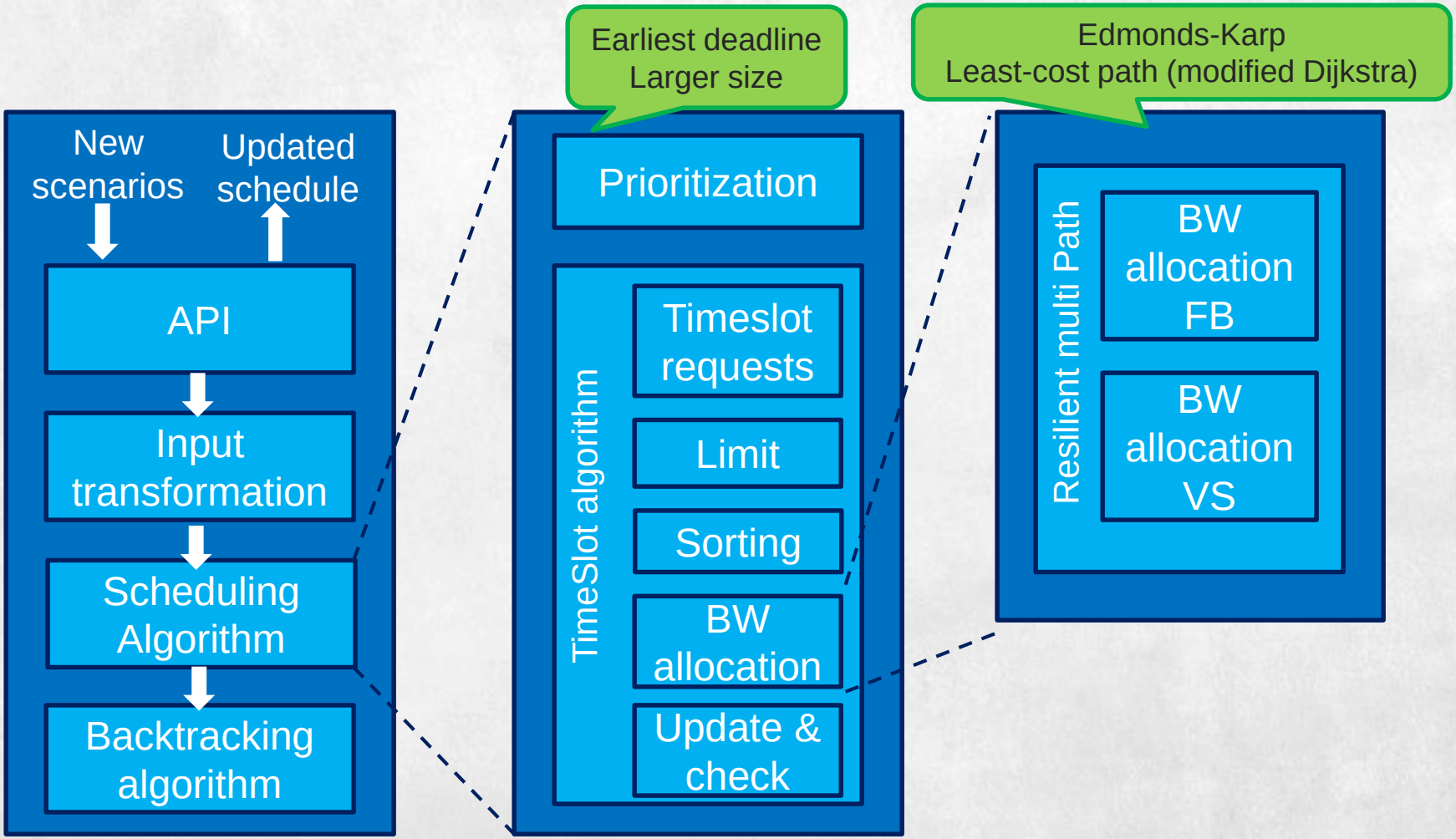


- ***Schedule***: a 3-D allocation among requests, links and time slots. Shows how much BW is allocated to each request over each link on each time slot.

Dynamic online approach

1. Requests arrive over time
2. The AR algorithm is invoked upon arrival of new scenarios
3. Requests in the previous schedule are updated:
   - Completely served scenarios are removed.
   - Partially executed requests are updated.
   - Possible dependency to the removed requests are adjusted.
4. New scenarios are given lower priority as rejecting admitted ones violates SLA
5. Reservation is re-optimized by re-routing existing reservations to accommodate new requests

AR scheduling algorithm



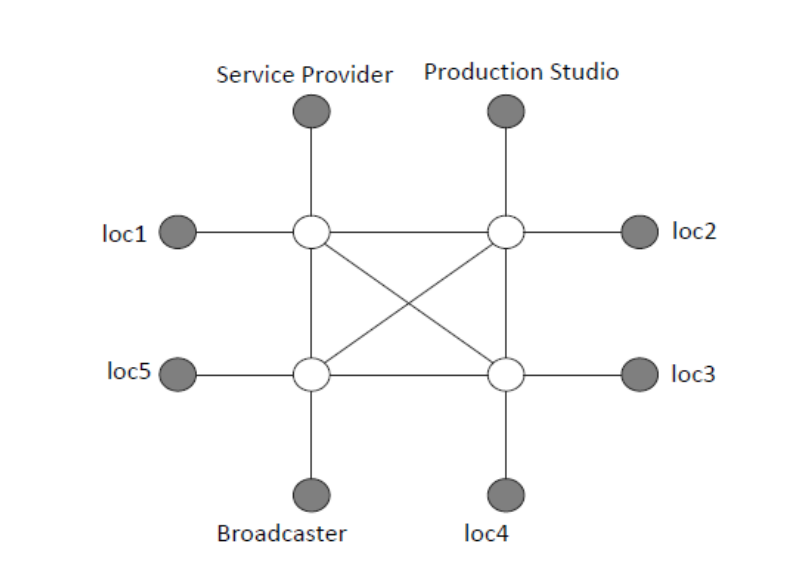
Resilient AR algorithms

- Advance Bandwidth Reservation with Path protection (ABRP)
  1. Find primary multipath
  2. Remove links
  3. Find secondary multipath

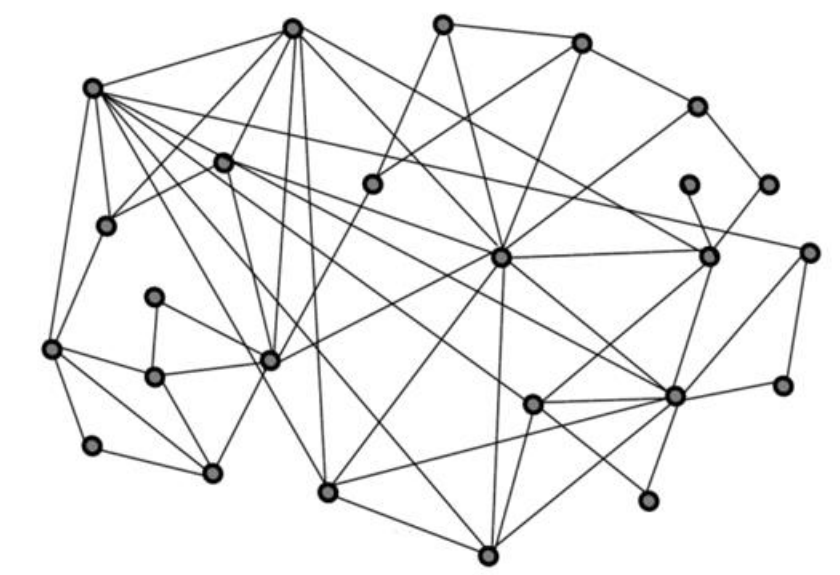
Primary and secondary paths are disjoint but might share links among themselves

- Advance Bandwidth Reservation with Segment protection (ABRS)
  - Use bridge links in both primary and secondary paths

Evaluation setup- Physical networks



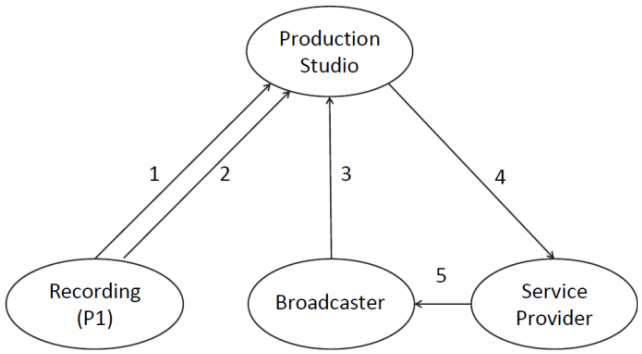
12-node



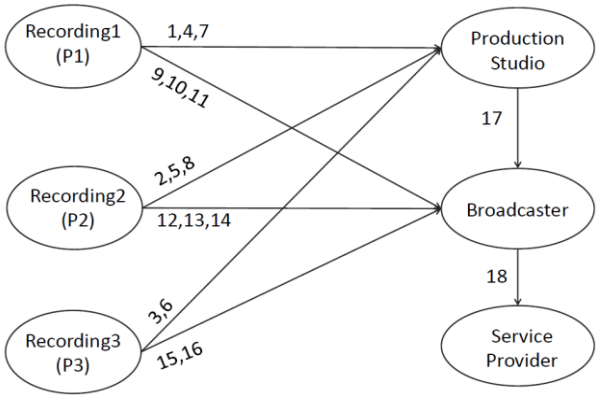
25-node

Evaluation setup - Scenarios

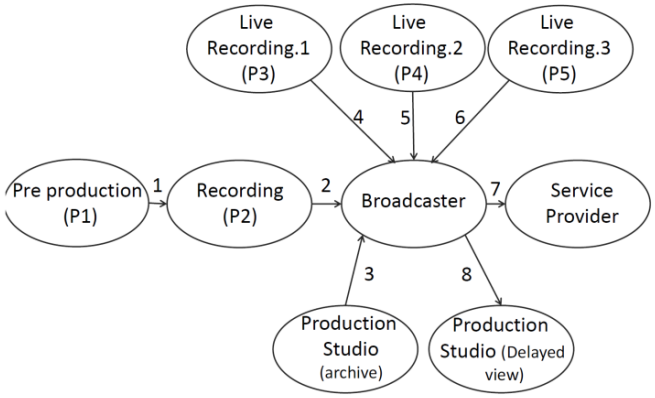
Use case 1: Soccer discussion program



Use case 2: Infotainment show

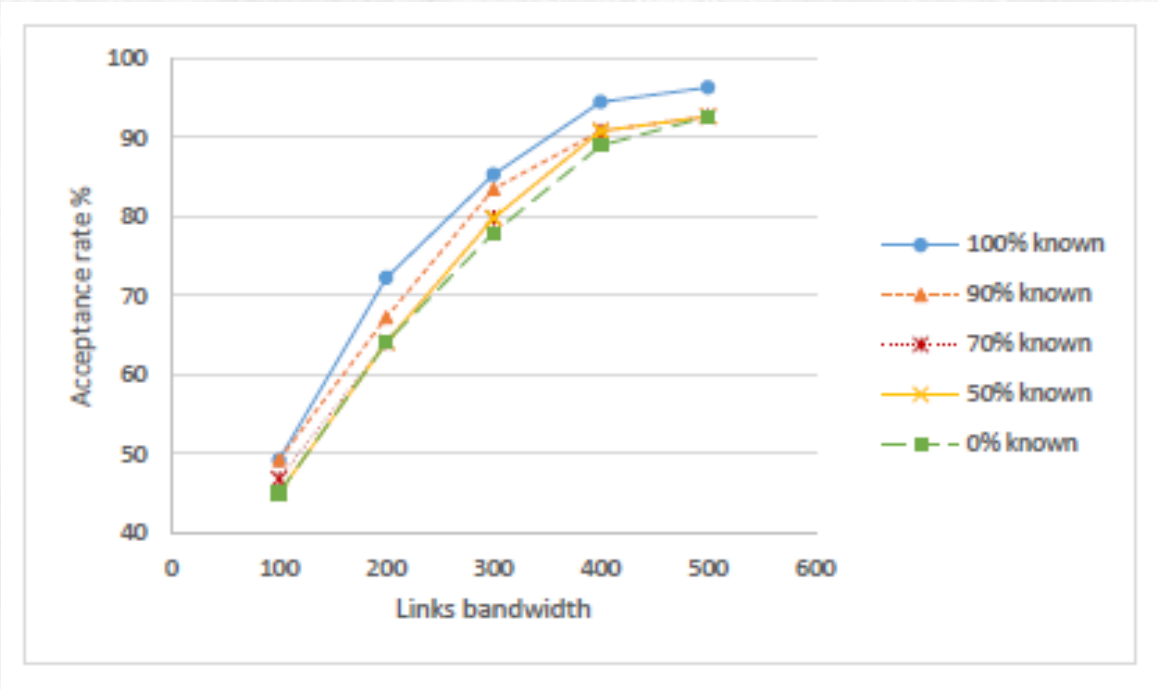


Use case 3: News Broadcast



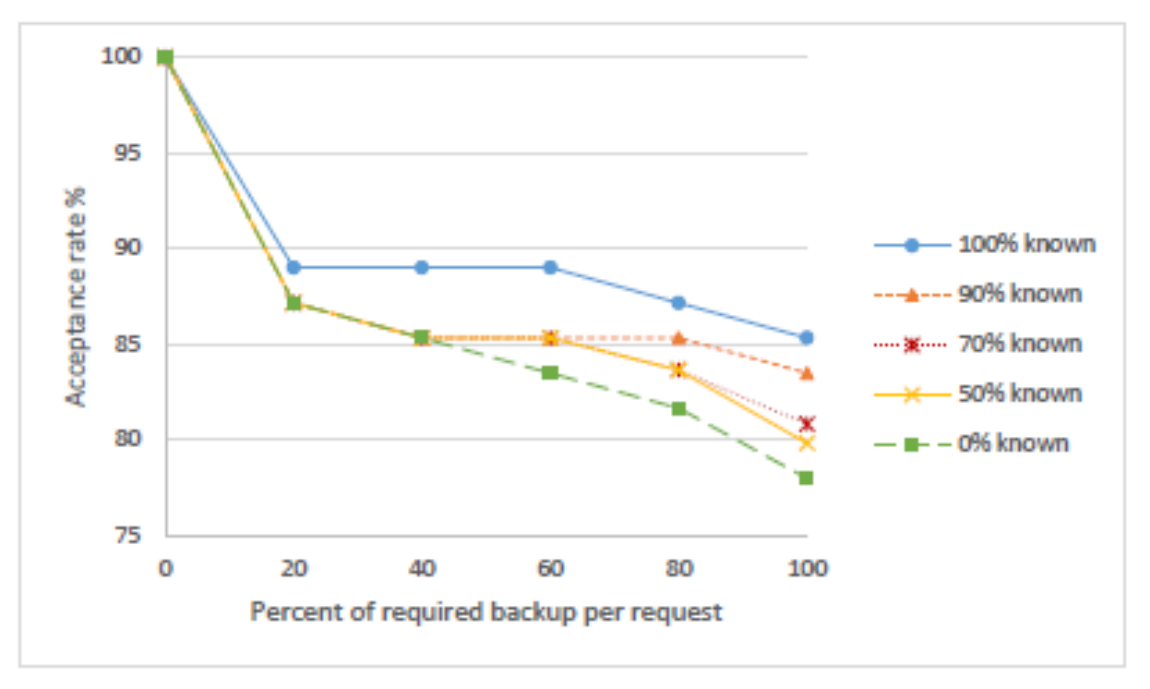
- High quality: 200 Mbps
- Low quality: 15 Mbps
- Randomized durations and locations

Impact of available bandwidth - ABRP



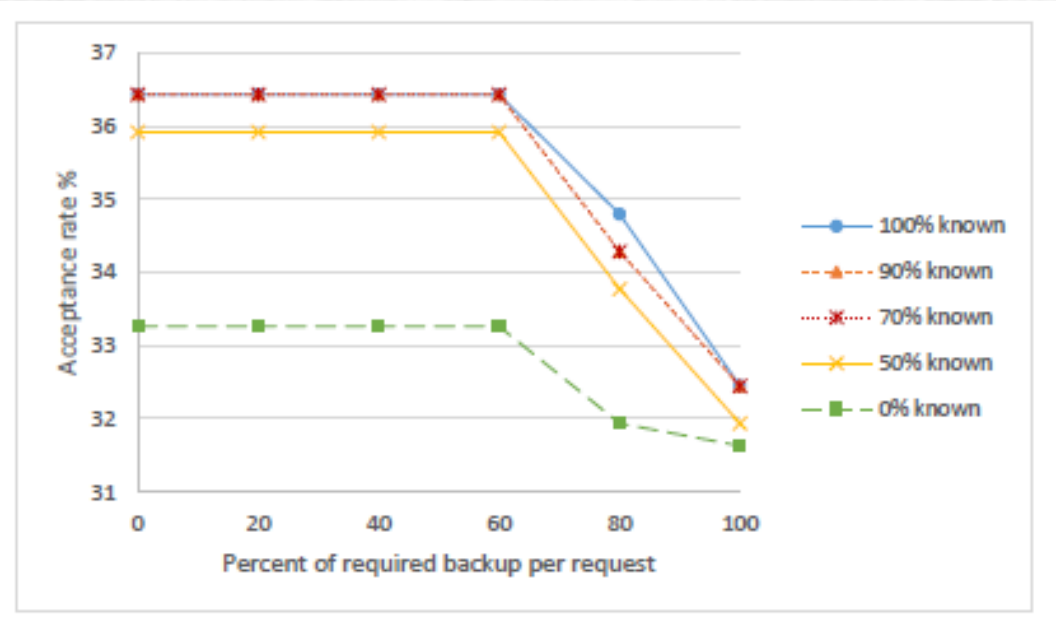
Topology: 25-node
Scenarios: 50
Requests: 519
Backup: 100%
Time slot size: 1 hour

Impact of backup requirement- ABRP



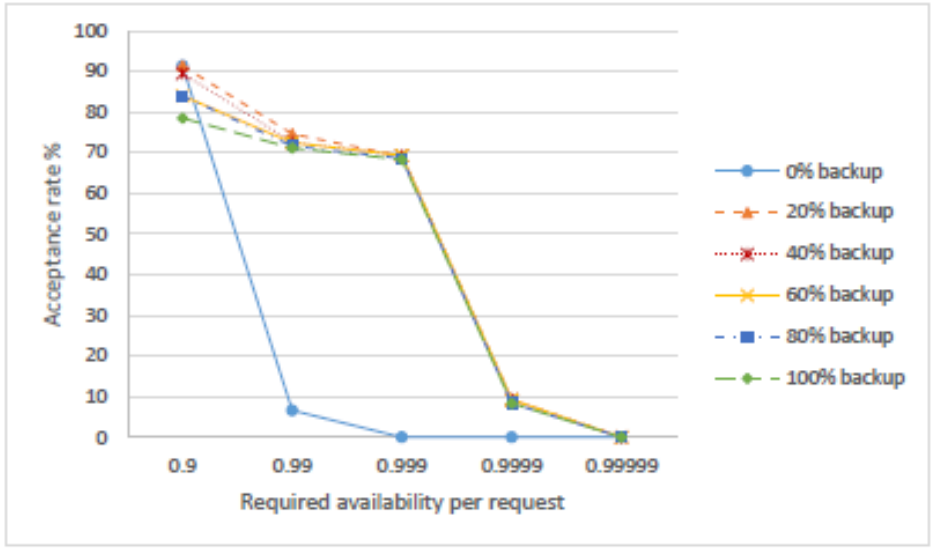
Topology: 25-node
Scenarios: 50
Requests: 519
Bandwidth: 300 Mbps
Time slot size: 1 hour

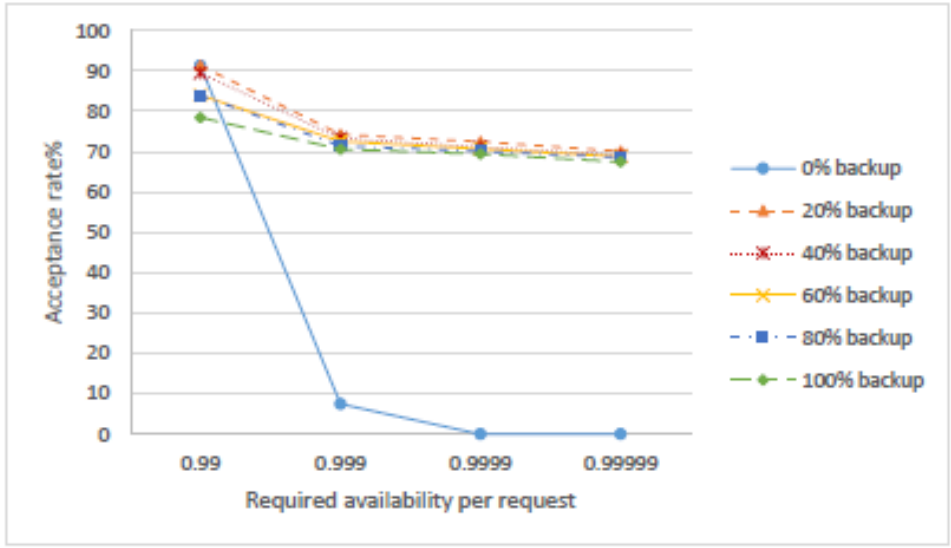
Impact of backup requirement- ABRS



Topology: 12-node
Scenarios: 20
Requests: 209
Bandwidth: 300 Mbps
Time slot size: 1 hour

Availability analysis





Topology: 25-node
Scenarios: 50
Requests: 519
Bandwidth: 500 Mbps
Time slot size: 1 hour
Link length: 100-1000 Km

Topology: 25-node
Scenarios: 50
Requests: 519
Bandwidth: 500 Mbps
Time slot size: 1 hour
Link length: 10-100 Km

Conclusion

- Predictable traffic in media production network can benefit from Advance Reservation techniques
- A resilient multipath, time-variable bandwidth reservation algorithm supporting flexible start times and request dependencies was proposed
- Results indicated that advance knowledge of the scenarios improves the network utilization and acceptance rate
- As part of the future work, we will extend the resilient algorithm with an online scheduler which uses the backup capacity in case of no failure

Thank you