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Announcement/Subscription/Publication

Message Based Communication for Heterogeneous Mobile Environments

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University of Rostock
Information and Communication Services Group
Rostock, Germany

29.04.2009

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Smart Environments   4 / 20

Heterogeneity

What does heterogeneity mean for smart environments?

► Incompatible communication techniques

  ► No homogeneous addressing scheme

  ► No guarantee for unique addresses

► Heterogeneous devices

► Heterogeneous applications

  ► Different document / data formats

  ► Different context

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Smart Environments 4 / 20

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Requirements

What requirements do smart environments demand from networking?

- ▶ Transparency from network topology

- ▶ Availability of information

- ▶ Independency of applications to the network / middleware

- ▶ Transparent aggregation / conversion / processing of data

- ▶ Decoupling in **space**

- ▶ Decoupling in **time**

- ▶ Decoupling in **threads**

- ▶ Decoupling in **semantics**

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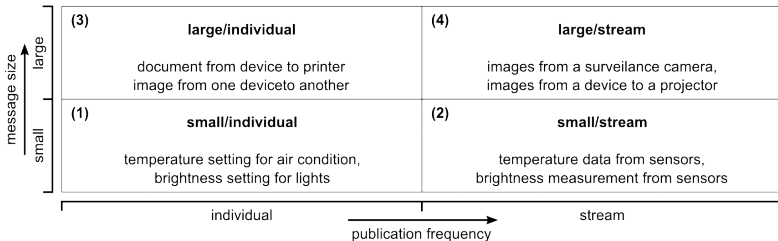
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Applications Scenarios

▶ Classification by message size and publication frequency
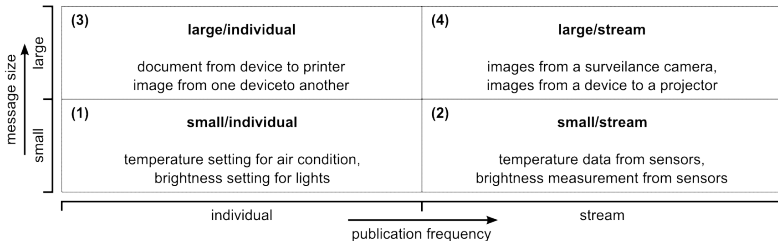
▶ focus on class 2 - small/stream

▶ small ⇒ size ≤ MTU
▶ large ⇒ size > MTU

▶ individual ⇒ single message
▶ stream ⇒ multiple messages

Applications Scenarios

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Applications Scenarios

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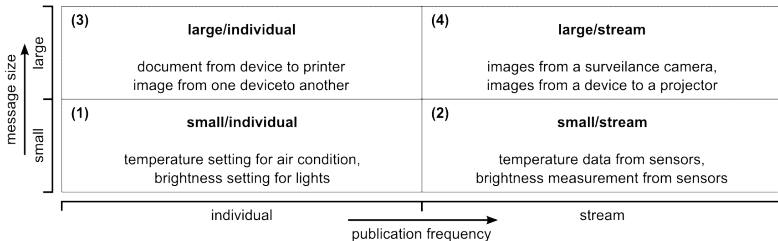| (3) **large/individual**	(4) **large/stream**
document from device to printer, image from one device to another	images from a surveilance camera, images from a device to a projector
(1) **small/individual**	(2) **small/stream**
temperature setting for air condition, brightness setting for lights	temperature data from sensors, brightness measurement from sensors

message size: large / small

individual ← publication frequency → stream

- small $\Rightarrow$ size $\leq$ MTU
- large $\Rightarrow$ size $>$ MTU
- individual $\Rightarrow$ single message
- stream $\Rightarrow$ multiple messages

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Applications Scenarios

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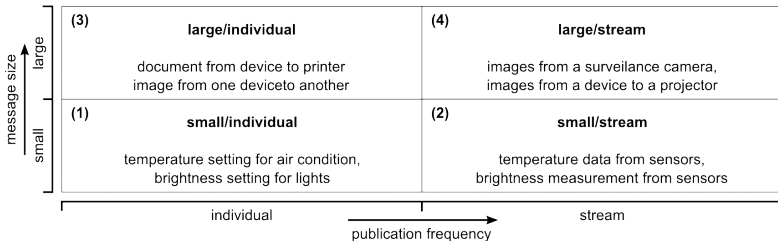
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System Architecture   8 / 20

Basic System Architecture

- ▶ 3 types of applications: sources, processors, sinks
- ▶ One broker per device
  - ▸ Decouples applications from each other and the network
  - ▸ Network communication to "neighboring" brokers

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System Architecture   8 / 20
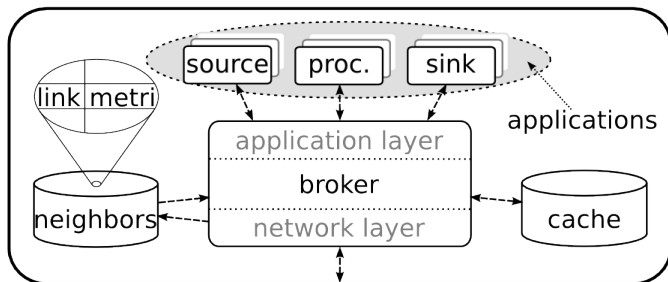
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System Architecture   8 / 20
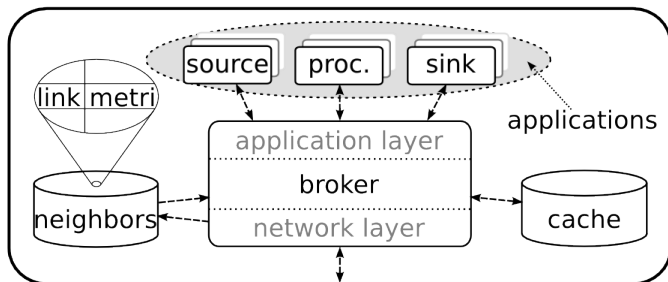
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System Architecture   8 / 20

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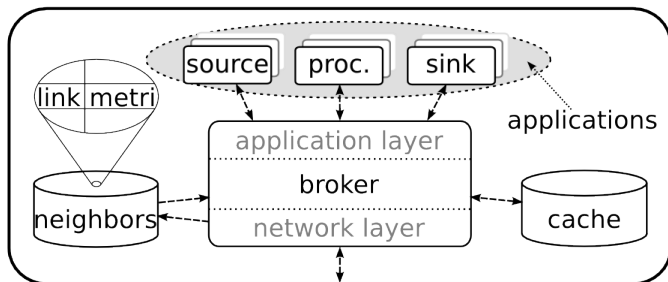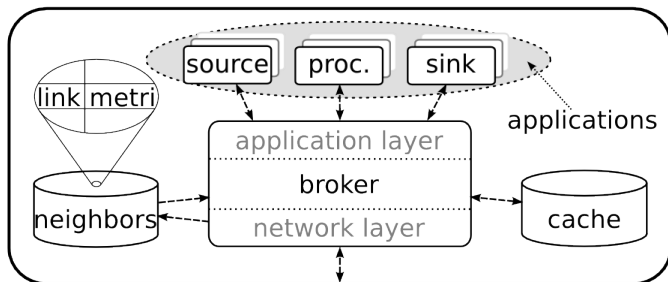 - ▶ Network communication to "neighboring" brokers

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System Architecture   9 / 20

ASP - Layers

- ▶ **Applications**
  - ▸ Source
  - ▸ Sink
  - ▸ Processor

- ▸ ASP Routing algorithm

- ▸ Network Abstraction Layer
  - ▸ Neighbor discovery
  - ▸ Neighbor cache updates
    (address, metric)
  - ▸ Reliable message delivery
  - ▸ MTU definition

- ▶ **Interface**
  - ▸ register
  - ▸ publish
  - ▸ receive announcements
  - ▸ subscribe
  - ▸ send announcements
  - ▸ receive publications
  - ▸ send publications

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System Architecture 9 / 20

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System Architecture   9 / 20

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System Architecture   9 / 20

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System Architecture   9 / 20

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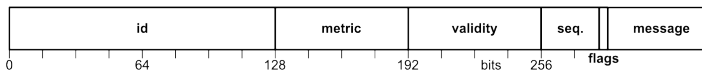   - ▶ send publications

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System Architecture   9 / 20

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Routing algorithm | 10 / 20

Phase 1: Announcement

id	metric	validity	seq.		message

0   64   128   192   bits   256   **flags**

- ▶ Task

    - ▶ Propagation of information availability

- ▶ Distribution

    - ▶ Flooding from source

    - ▶ ... through all processors

    - ▶ ... keeping best path metric

- ▶ Content

    - ▶ First dataset or special dataset

    - ▶ Size ≤ MTU

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Routing algorithm   10 / 20
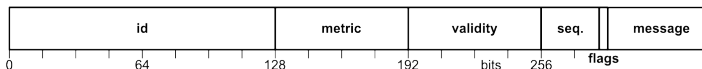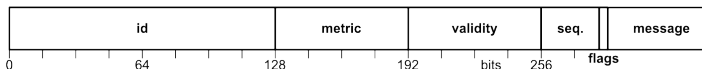
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Routing algorithm   10 / 20

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id		metric	validity	seq.	message

0   64   128   192   bits   256   **flags**

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  - ▶ Flooding from source
  - ▶ . . . through all processors
  - ▶ . . . keeping best path metric

- ▶ Content
  - ▶ First dataset or special dataset
  - ▶ Size $\leq$ MTU

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Routing algorithm   11 / 20

Phase 2: Subscription

id	subscriberId	metric	sequence	type

0   64   128   192   256   bits

- ▶ Task
  - ▶ Control messages
    - ▶ Subscribe/Unsubscribe from sink towards source
    - ▶ Broken path signalling from breakage towards source

- ▶ Distribution
  - ▶ Best path according to path metric
  - ▶ Path becomes active path on subscribe

- ▶ Content
  - ▶ Only control message
  - ▶ Size ≪ MTU

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Routing algorithm   11 / 20

Phase 2: Subscription

id		subscriberId	metric	sequence	type
0	64	128	192	256	bits

- ▶ Task
    - ▶ Control messages
        - ▶ Subscribe/Unsubscribe from sink towards source
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- ▶ Content
    - ▶ Only control message
    - ▶ Size ≪ MTU

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Phase 2: Subscription

id			subscriberId		metric		sequence	type
0	64	128		192		256		bits

- ▶ Task
  - ▶ Control messages
    - ▶ Subscribe/Unsubscribe from sink towards source
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  - ▶ Best path according to path metric
  - ▶ Path becomes active path on subscribe

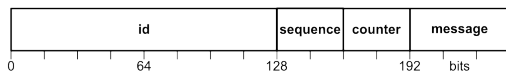- ▶ Content
  - ▶ Only control message
  - ▶ Size $\ll$ MTU

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Routing algorithm   12 / 20

Phase 3: Publication

id		sequence	counter	message

0   64   128   192   bits

- ▶ Task
  - ▶ Information delivery

- ▶ Distribution
  - ▶ Single publication per active path

- ▶ Content
  - ▶ Dataset
  - ▶ Size ≤ MTU (only in class 2)
  - ▶ Otherwise fragmentation

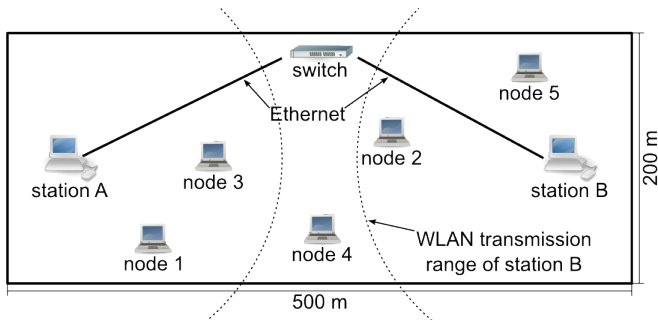| Introduction	Announcement/Subscription/Publication	Evaluation	Conclusion and Future Work
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Routing algorithm   12 / 20

Phase 3: Publication

id	sequence	counter	message

0   64   128   192   bits

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Routing algorithm   12 / 20

Phase 3: Publication

id		sequence	counter	message

0   64   128   192   bits

- ▶ Task
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- ▶ Distribution
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- ▶ Content
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    - ▶ Size $\leq$ MTU (only in class 2)
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Methodolody   14 / 20

Methodolody

▶ Simple very mobile scenario
  ▶ 1 mobile temperature source (Celsius)
  ▶ 2 stationary temperature processors
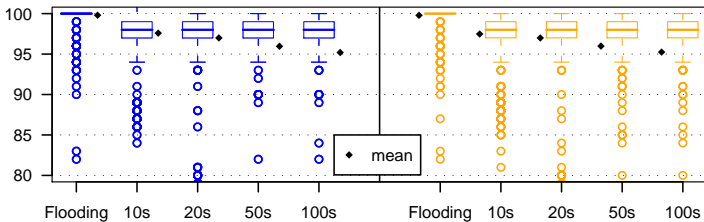 ▶ 2 mobile temperature sinks (Fahrenheit, Kelvin)

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Methodolody

▶ Simple very mobile scenario
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- ▶ 2 mobile temperature sinks (Fahrenheit, Kelvin)

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Methodolody   14 / 20

Methodolody

- ▶ Scenario settings
    - ▶ Publication of 100 messages
    - ▶ 1 message per second
    - ▶ Flooding vs. ASP with differing announcement validity

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Methodolody
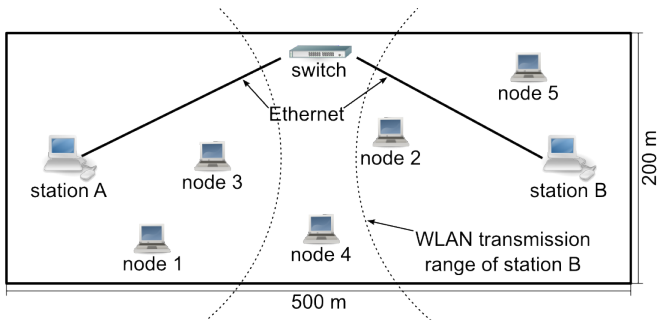
- ▶ Simulation environment
  - ▶ OMNeT++ version 3.3
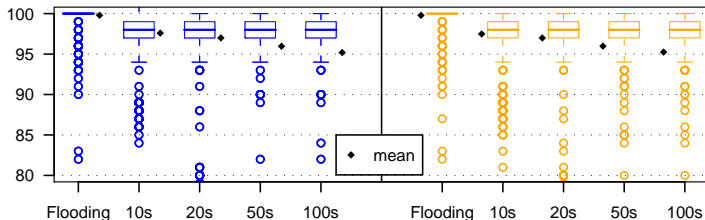 - ▶ INET Framework 20061020
  - ▶ 1000 runs per configuration

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Results   15 / 20

Completeness

- Flooding shows a 99.8% delivery rate
  - There are transmissions that can not be delivered
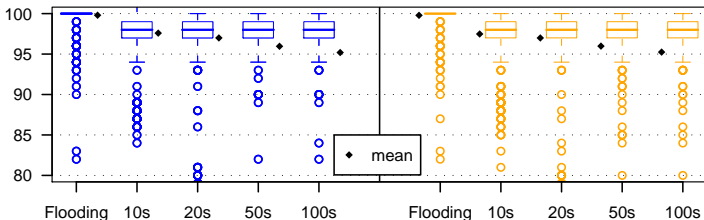
- Delivery rate of ASP drops with announcement validity

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Evaluation
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Conclusion and Future Work
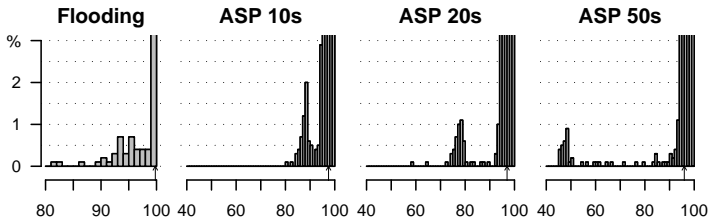○○○

Results
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Completeness

- ▶ Flooding shows a 99.8% delivery rate
    - ▶ There are transmissions that can not be delivered
- ▶ Delivery rate of ASP drops with announcement validity

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Results   15 / 20

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Results   15 / 20
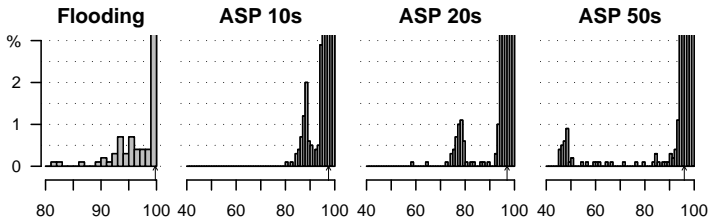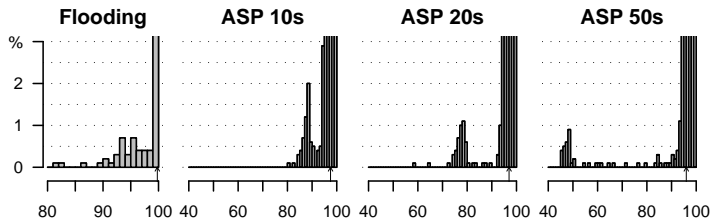
Completeness

- ▶ If a publication can not be delivered

  - ▸ One message is lost (no retransmission)

  - ▸ A new announcement is initiated

- ▶ If an announcement can not be delivered

  - ▸ No message is delivered for the validity period

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Results   15 / 20
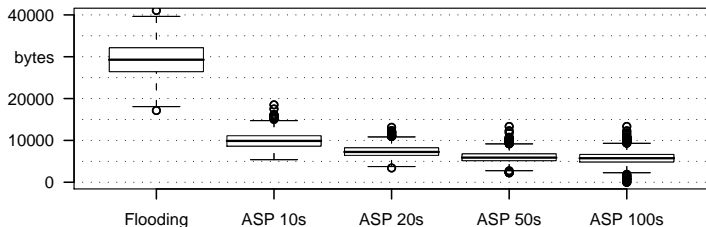
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Completeness

- ▶ If a publication can not be delivered
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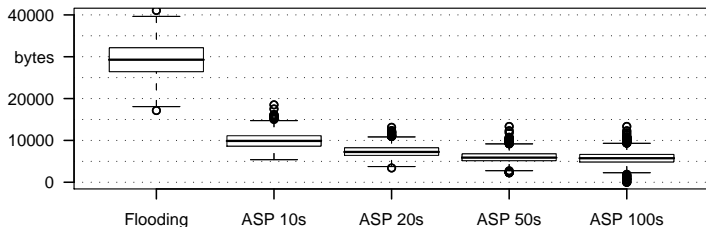 - ▶ No message is delivered for the validity period

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Network Load

- ▶ Load = data received from the network by NAL
- ▶ ASP generates from 33% to about 25% the load of Flooding

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Network Load

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Outline

| Introduction | Announcement/Subscription/Publication | Evaluation | Conclusion and Future Work |
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Conclusion

- ▶ Benefits
  - ▶ Independent of communication technology
  - ▶ Adaptable to high degree of mobility
  - ▶ Largly reduced load compared to flooding

- ▶ Shortcommings
  - ▶ Announcement validity problem
    - ▶
    - ▶
  - ▶ Decoupling in time only for message stream

Conclusion

- ▶ Benefits
    - ▶ Independent of communication technology
    - ▶ Adaptable to high degree of mobility
    - ▶ Largly reduced load compared to flooding

- ▶ Shortcommings
    - ▶ Announcement validity problem
        - ▶ High -> less load but more messages are lost
        - ▶ Low -> less messages are lost but higher load
    - ▶ Decoupling in time only for message stream

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Future Work

- ▶ Announcement caching
  - ▶ Overcome announcement validity problem
  - ▶ Allows for decoupling in time for each message

- ▶ Extension to and validation in other application classes
  - ▶ Large publications lead to

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Future Work

- ▶ Announcement caching
  - ▶ Overcome announcement validity problem
  - ▶ Allows for decoupling in time for each message

- ▶ Extension to and validation in other application classes
  - ▶ Large publications lead to
    - ▶ Message loss being crucial
    - ▶ High network load being a problem

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Questions ?! Discussion   20 / 20

Thank you for your attention

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