Enhancing Privacy Through Time Aggregation of Load Profiles in Energy Management

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- Privacy in demand side management (DSM)
- Time aggregation (TA) methods
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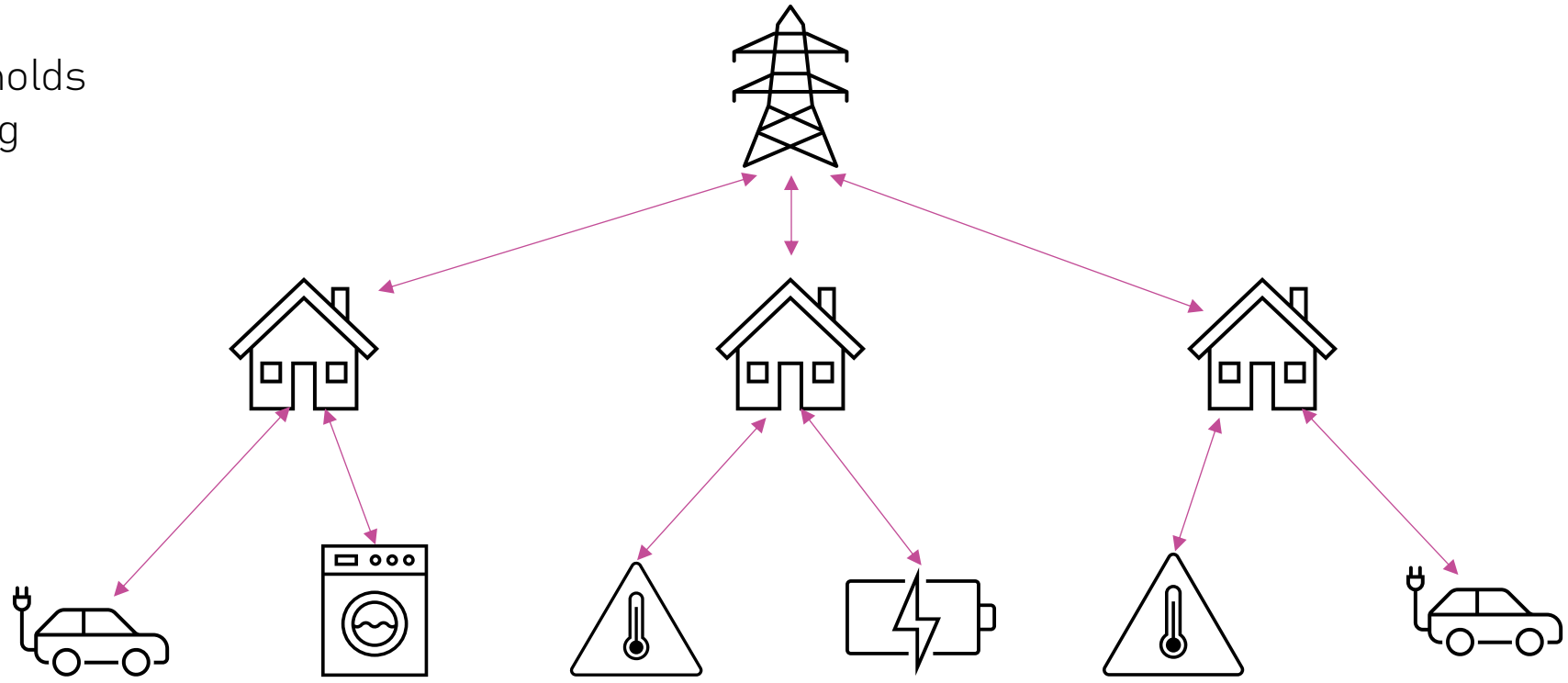
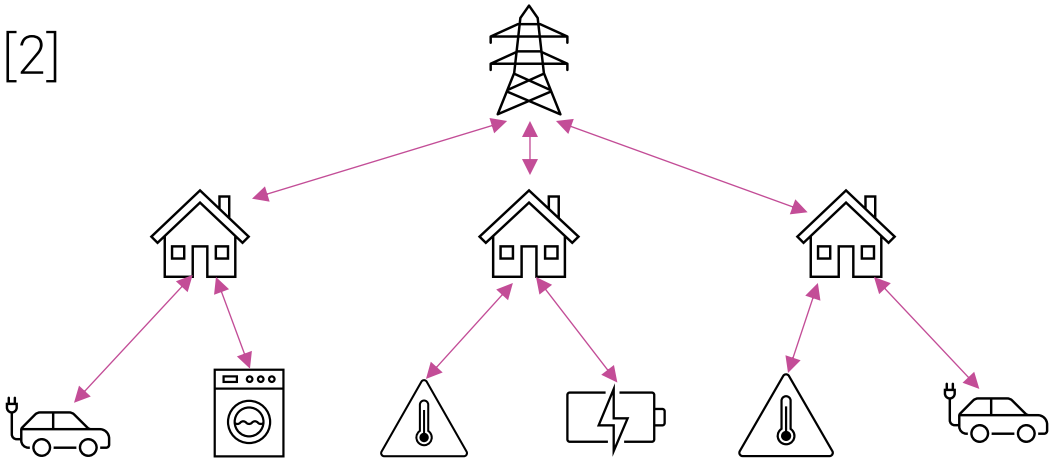
Demand Side Management (DSM)

20 households
Scheduling



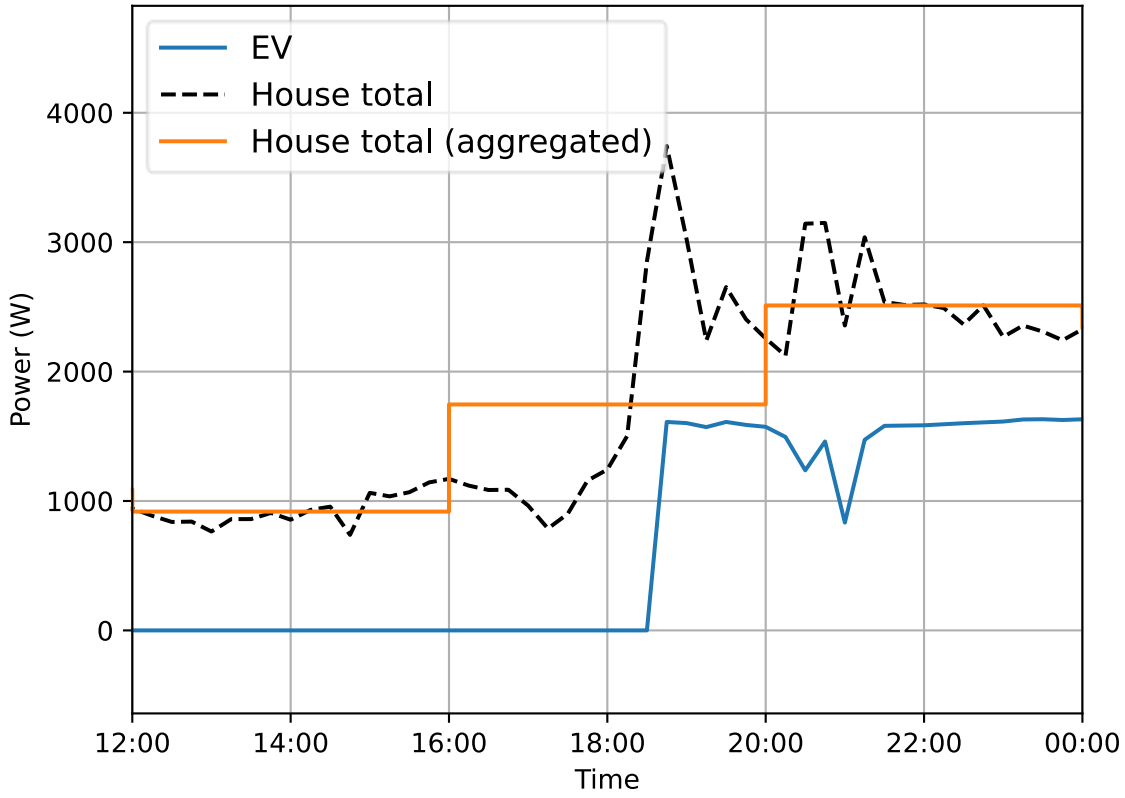
Privacy

- Privacy by design concept introduced by Cavoukian [1]
- Hoepman suggested strategies: AGGREGATE [2]

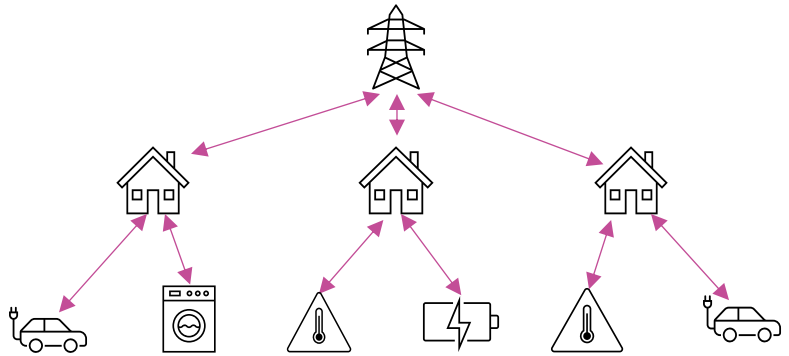


[1] A. CAVOUKIAN, "PRIVACY BY DESIGN: THE DEFINITIVE WORKSHOP. A FOREWORD BY ANN CAVOUKIAN, PH.D," IDENTITY IN THE INFORMATION SOCIETY, VOL. 3, NO. 2, PP. 247–251, AUG. 2010
[2] J.-H. HOEPMAN, "PRIVACY DESIGN STRATEGIES," IN ICT SYSTEMS SECURITY AND PRIVACY PROTECTION, SER. IFIP ADVANCES IN INFORMATION AND COMMUNICATION TECHNOLOGY. SPRINGER BERLIN HEIDELBERG, 2014, PP. 446–459

Privacy through aggregation



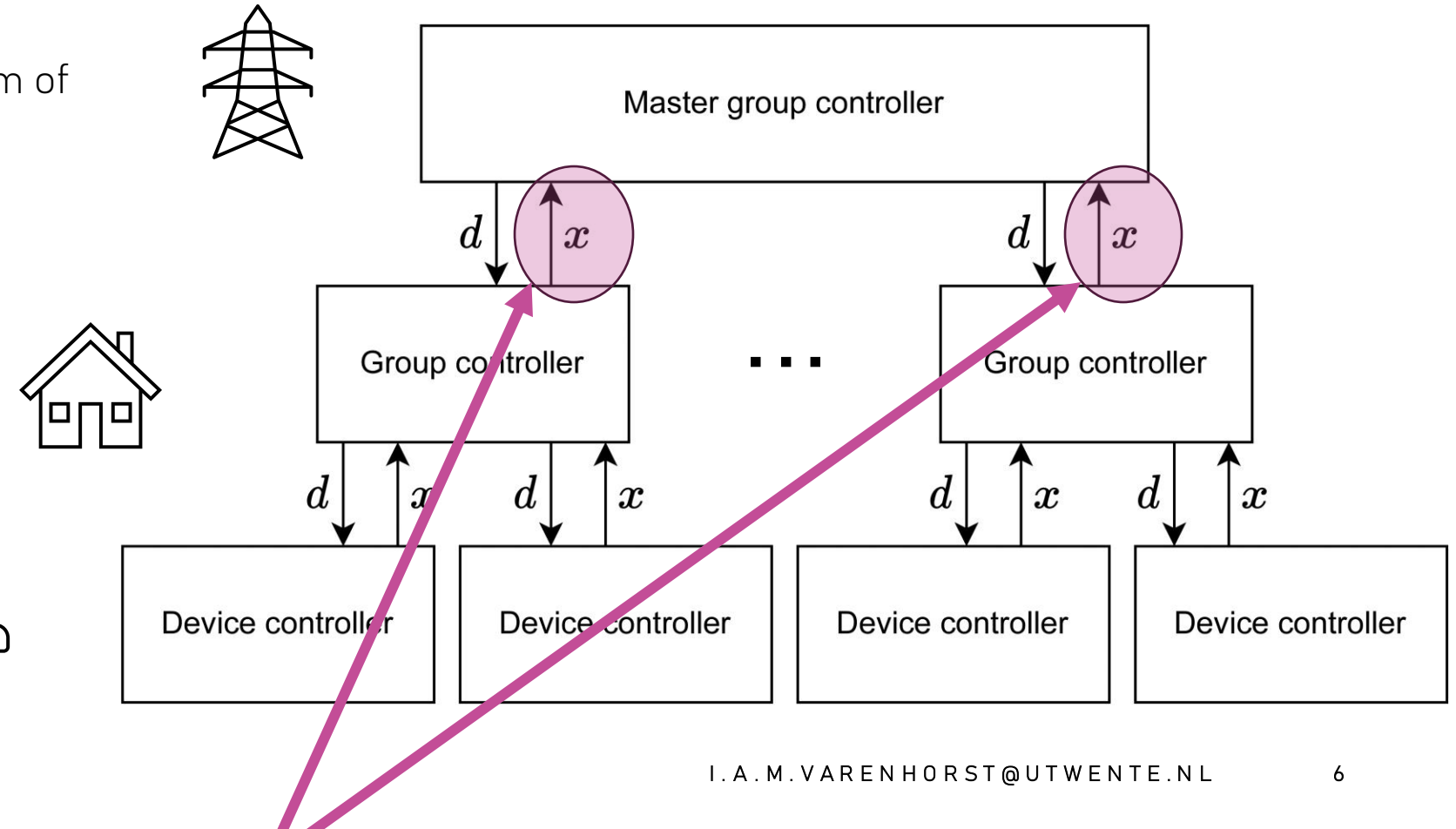
Black: no aggregation, 15-min intervals
Orange: aggregated profile, 4-hour intervals



DSM method – Profile Steering

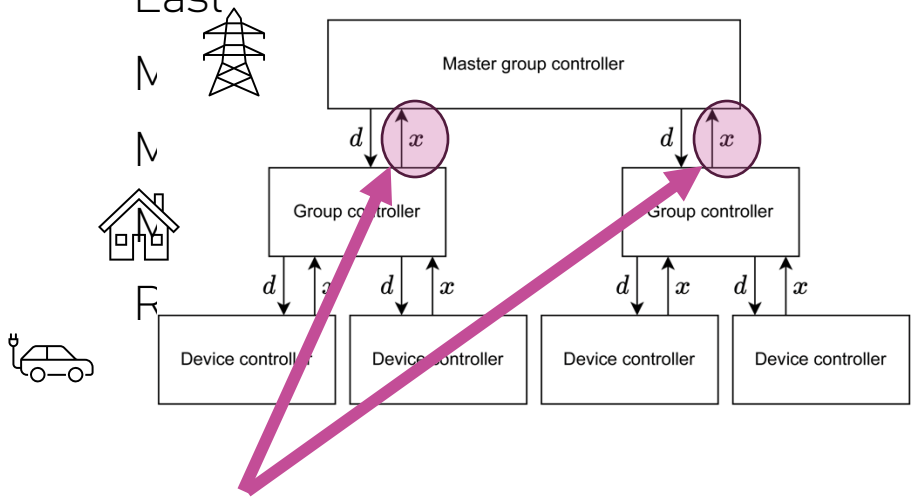
Goal: Minimize Euclidean norm of the transformer profile $\|x\|_2$

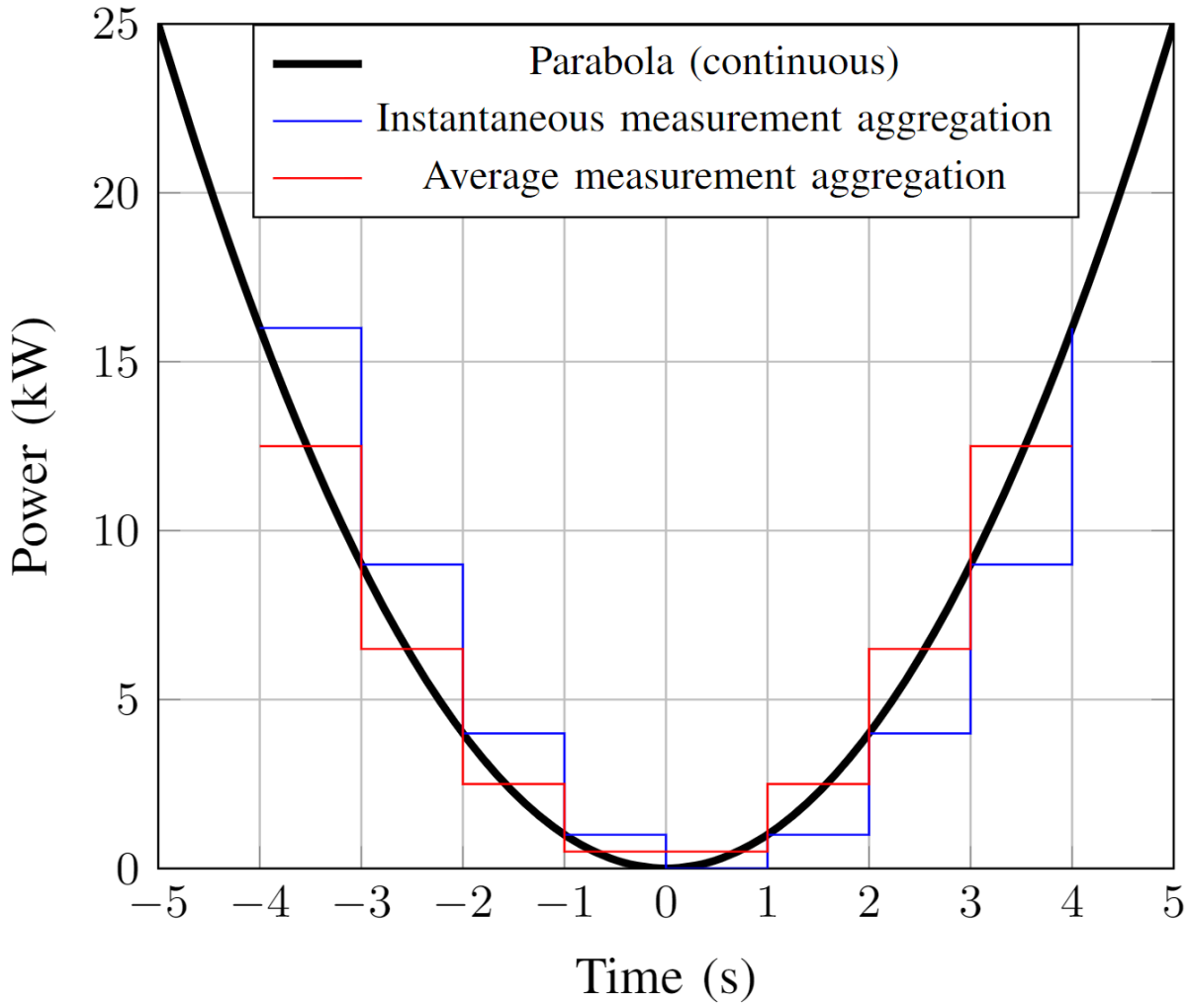
Default: 15-minute intervals
K = 2: 30-minute intervals
K = 4: 1-hour intervals



Time aggregation (TA) methods

- Considered methods:
  - Mean
  - First
  - Last
  - M
  - M
  - F

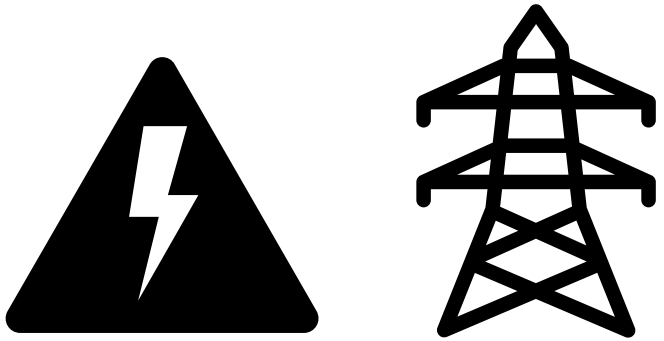




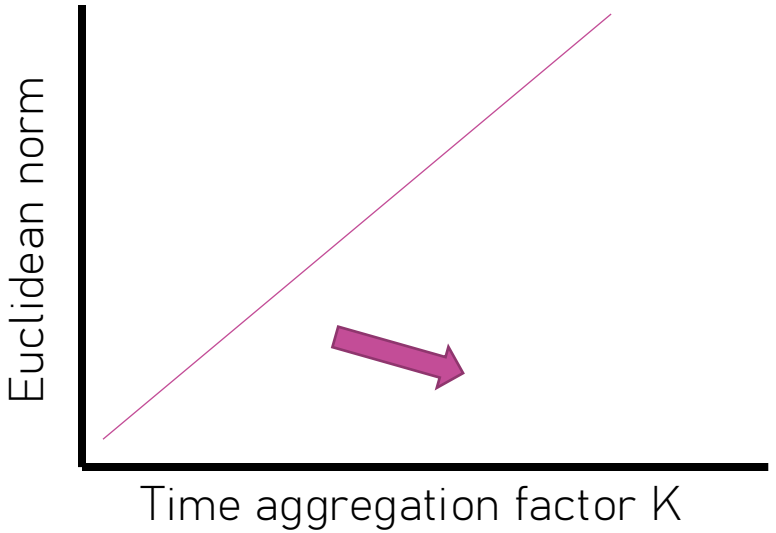
KPI's

Performance evaluation of TA

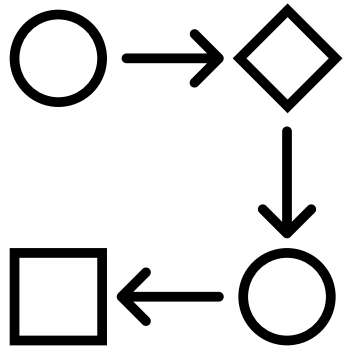
KPI's – Euclidean norm



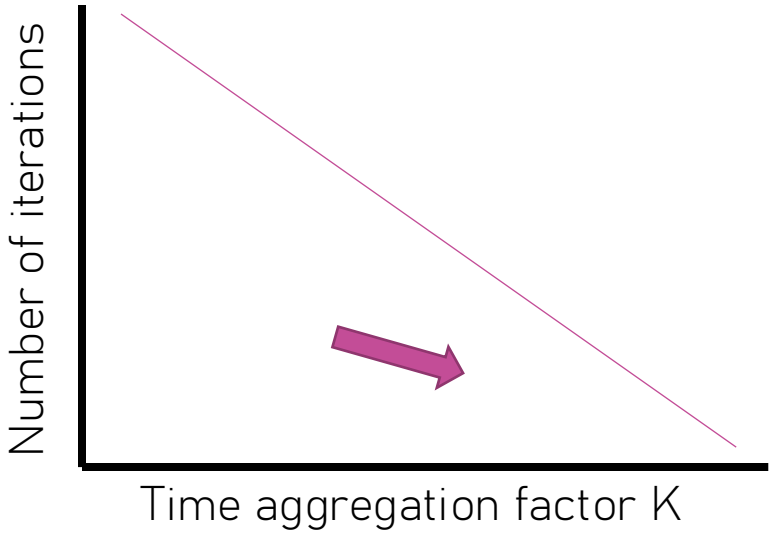
- Profile Steering DSM method
- Goal: Minimize Euclidean norm of the transformer profile $\|x\|_2$



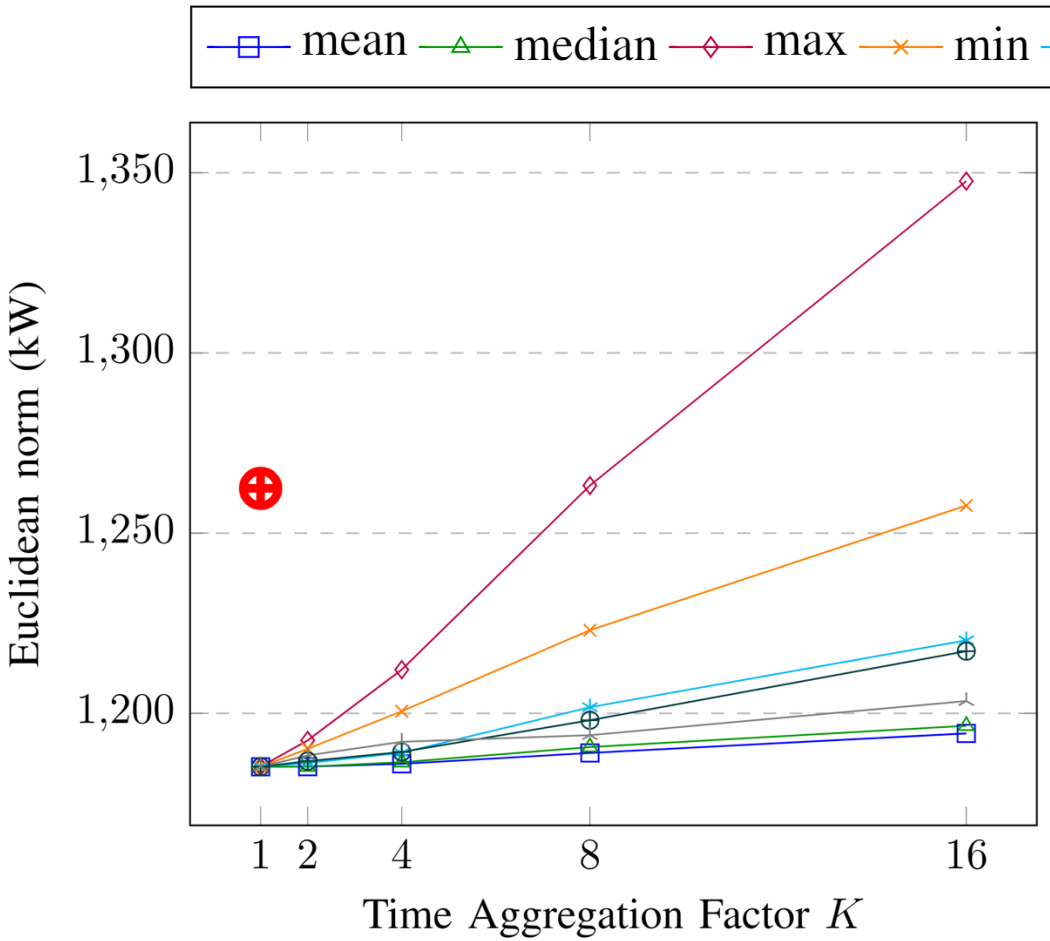
KPI's – number of iterations



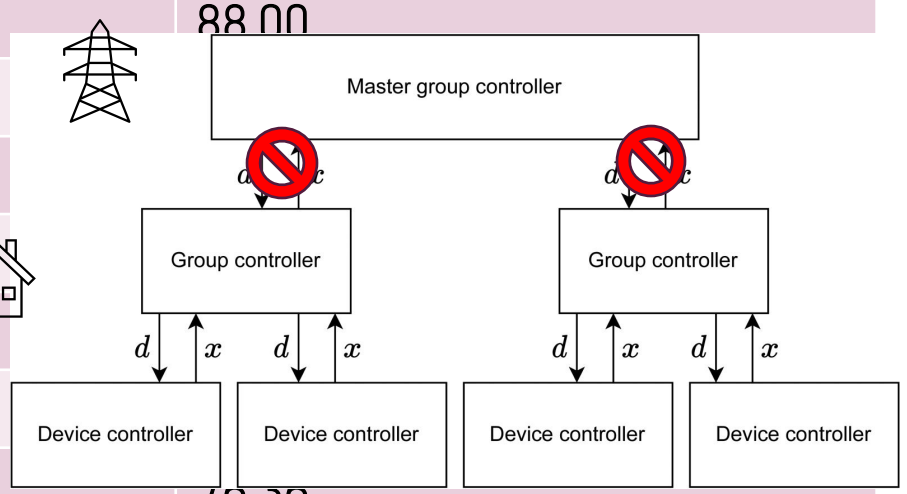
- Profile Steering DSM method



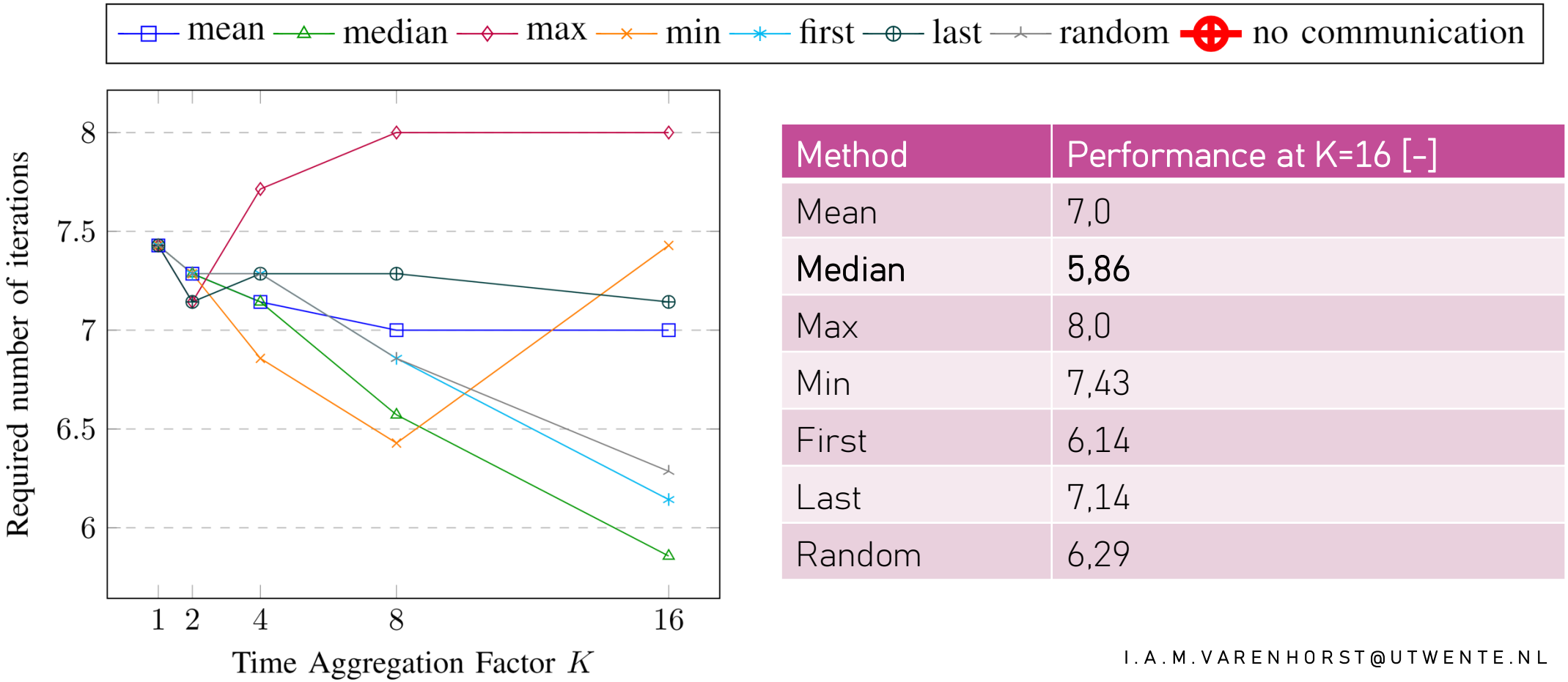
Evaluation – Euclidean norm



Method	Performance at K=16 [% of K=1]
Mean	88,00
Median	
Max	
Min	
First	
Last	
Random	76,36

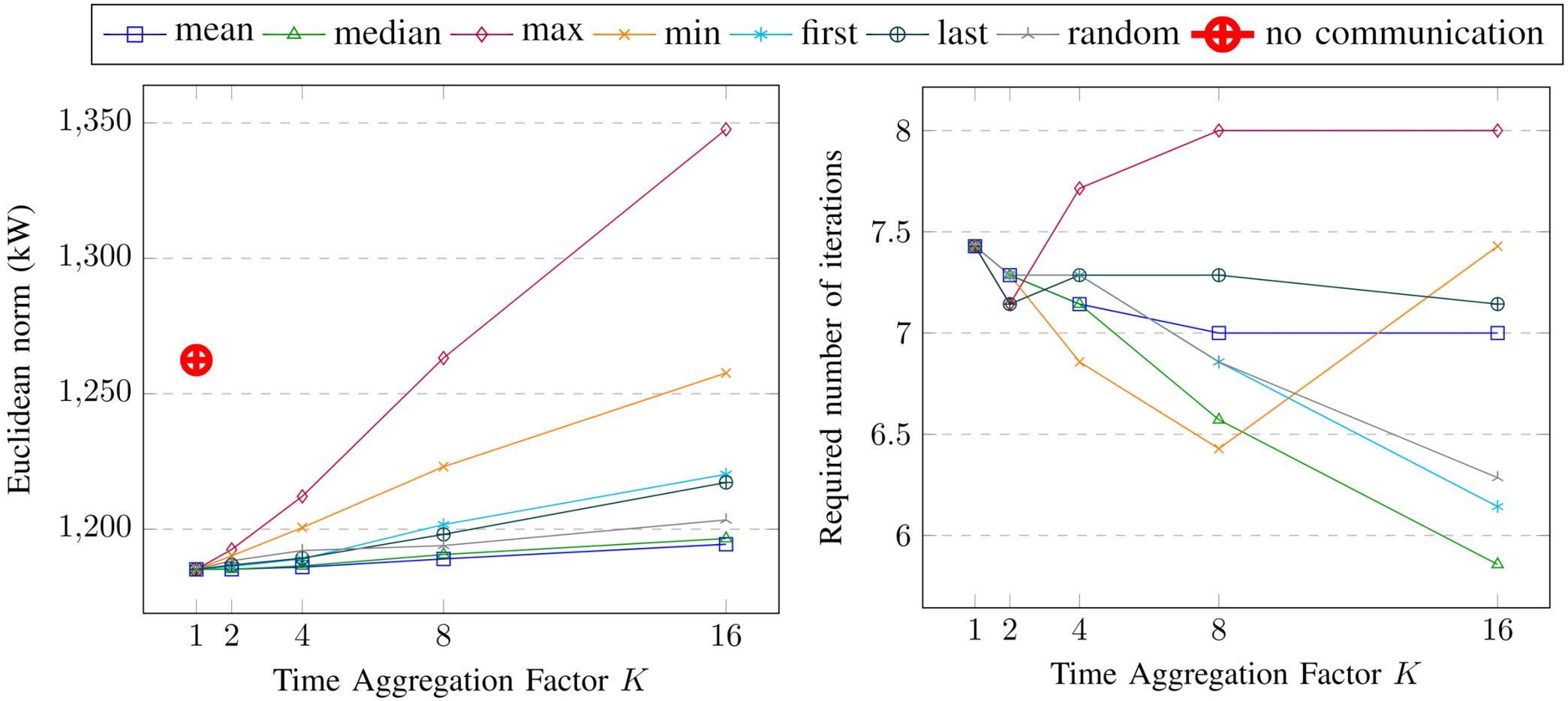


Evaluation – number of iterations



Method	Performance at K=16 [-]
Mean	7,0
Median	**5,86**
Max	8,0
Min	7,43
First	6,14
Last	7,14
Random	6,29

Evaluation – comparison



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Conclusion

- Time aggregation provides a significant privacy benefit, while retaining DSM performance
- For $K = 16$, the required number of iterations is reduced by 21%, for a 15% reduction in objective value performance using the median method.

Take home message: think about the required granularity of data when developing new methods.

- Future work:

  Influence of TA on other optimization objectives

Evaluation – comparison (high K)