KATHOLIEKE UNIVERSITEIT
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Applications and trends in wireless acoustic sensor networks:
a signal processing perspective

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IEEE SCVT
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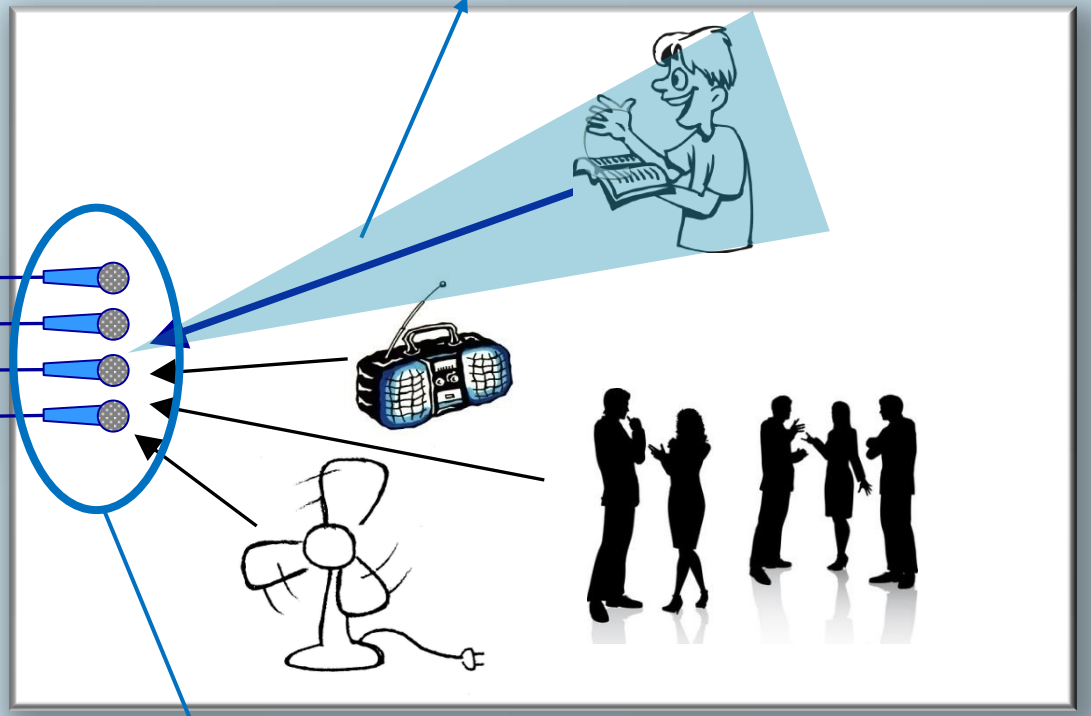
Traditional microphone arrays

☹ Long distance (large attenuation)



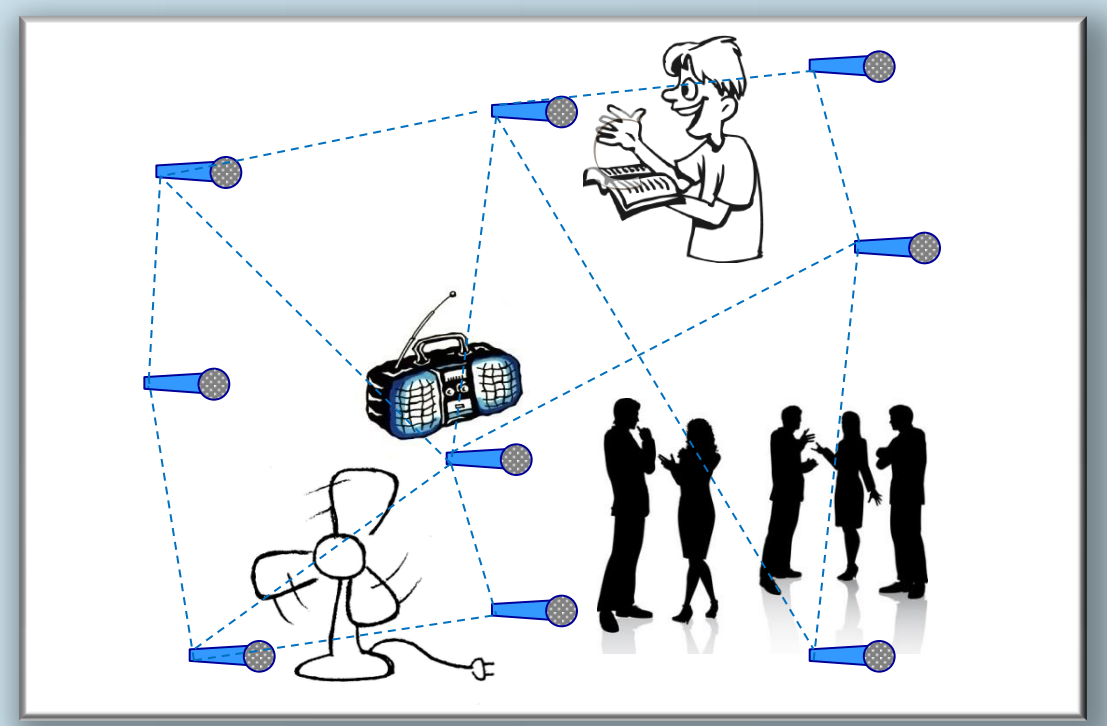
Noise reduction

☺ Centralized processing

☹ Number of microphones is limited (e.g. hearing aids)

Wireless acoustic sensor networks

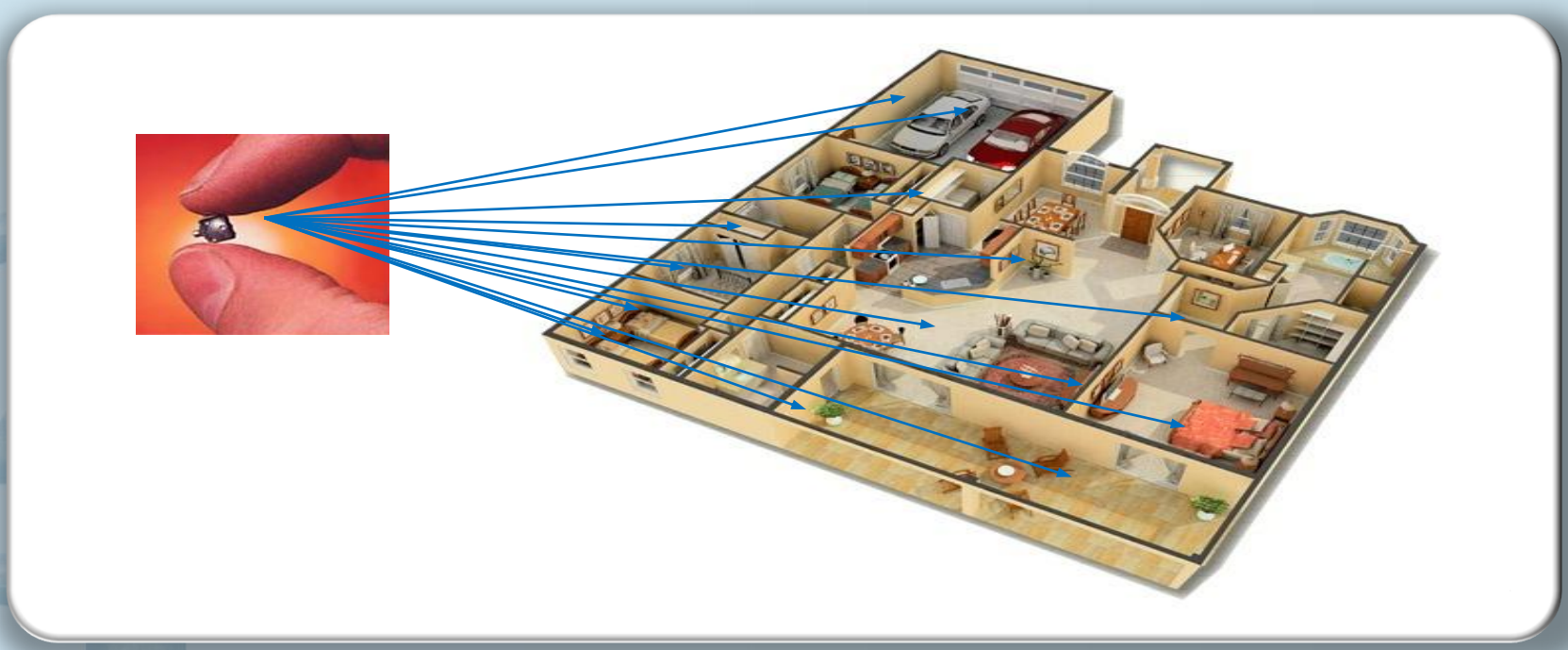
- ☺ **Microphones close to desired source**
- ☺ **Many more microphones** (wireless)



Application:
noise reduction in hearing aids

Application: ambient intelligence

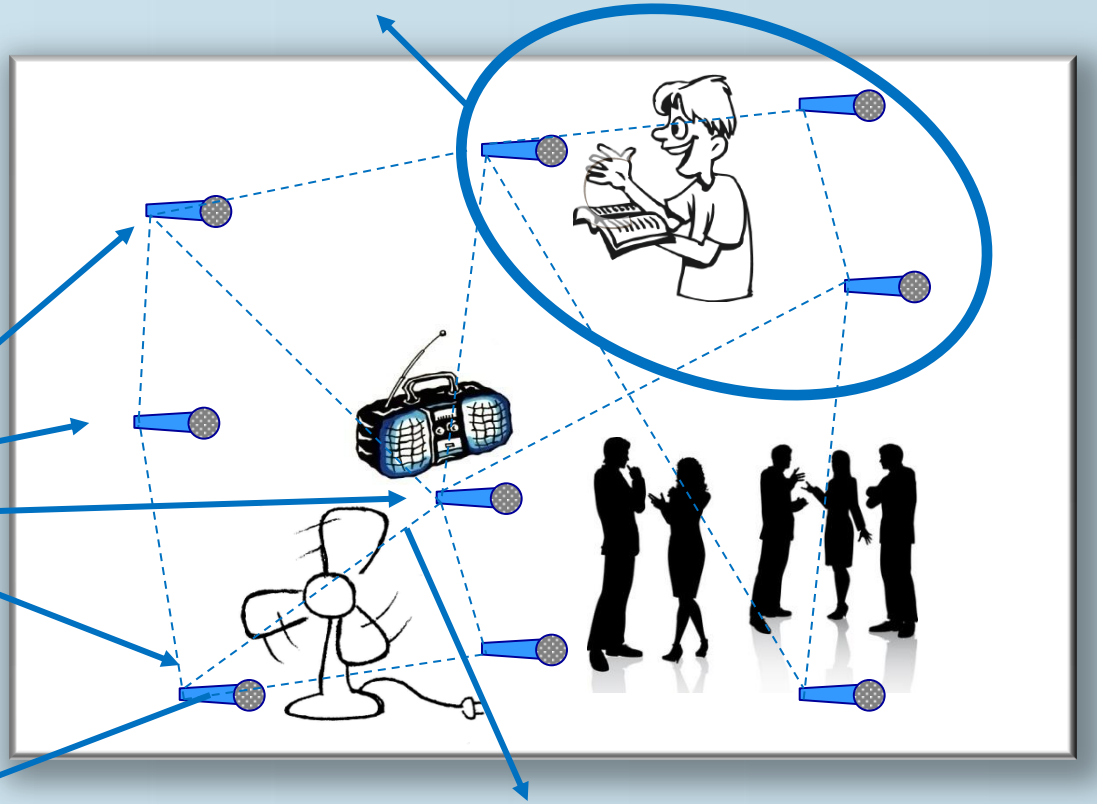
- ‘Intelligent’ environment that is sensitive and responsive to the presence of people.
- **Sensors** and **processors** are inconspicuously incorporated in the environment, and are **wirelessly** connected with each other.



Wireless acoustic sensor networks

Challenges…

4) Subset selection



3) Distributed processing

1) Unknown and changing positions

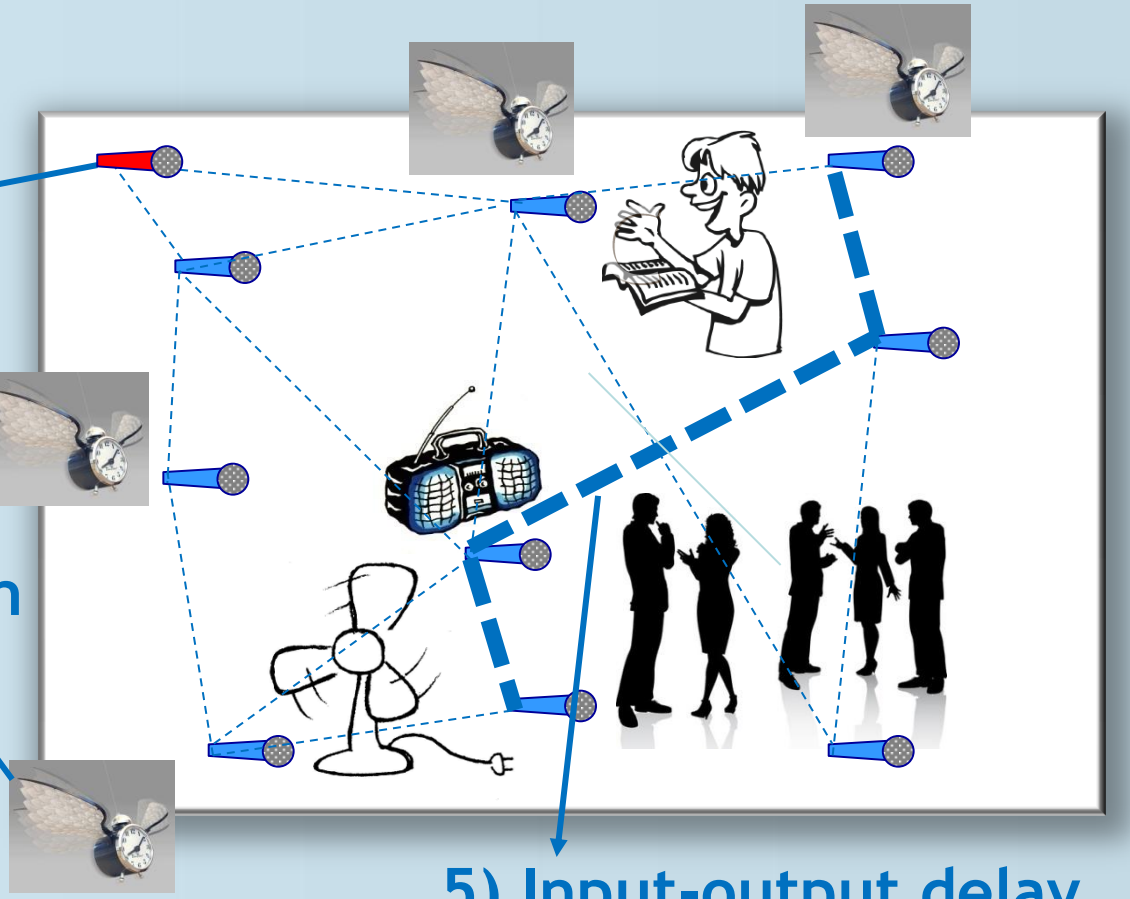
2) Efficient usage of bandwidth

Wireless acoustic sensor networks

Challenges…

6) Scalability

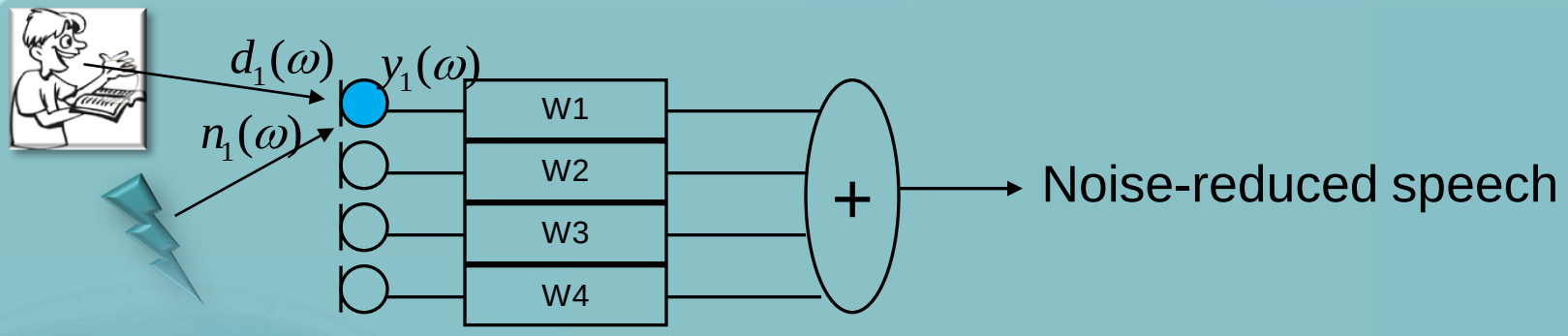
7) Synchronization



5) Input-output delay

Signal fusion for speech enhancement

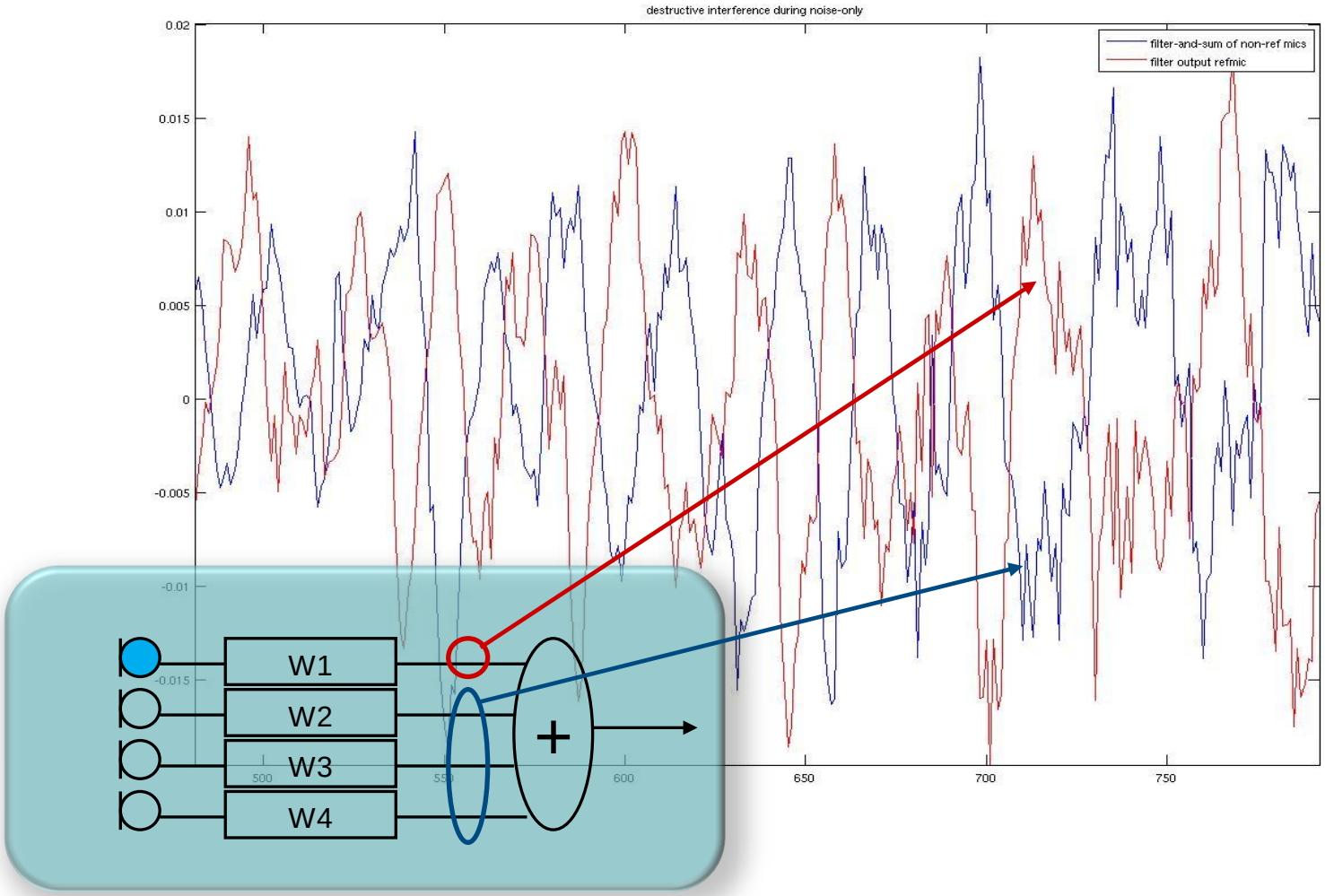
- Goal: noise reduction by fusing microphone signals
- Filter-and-sum structure



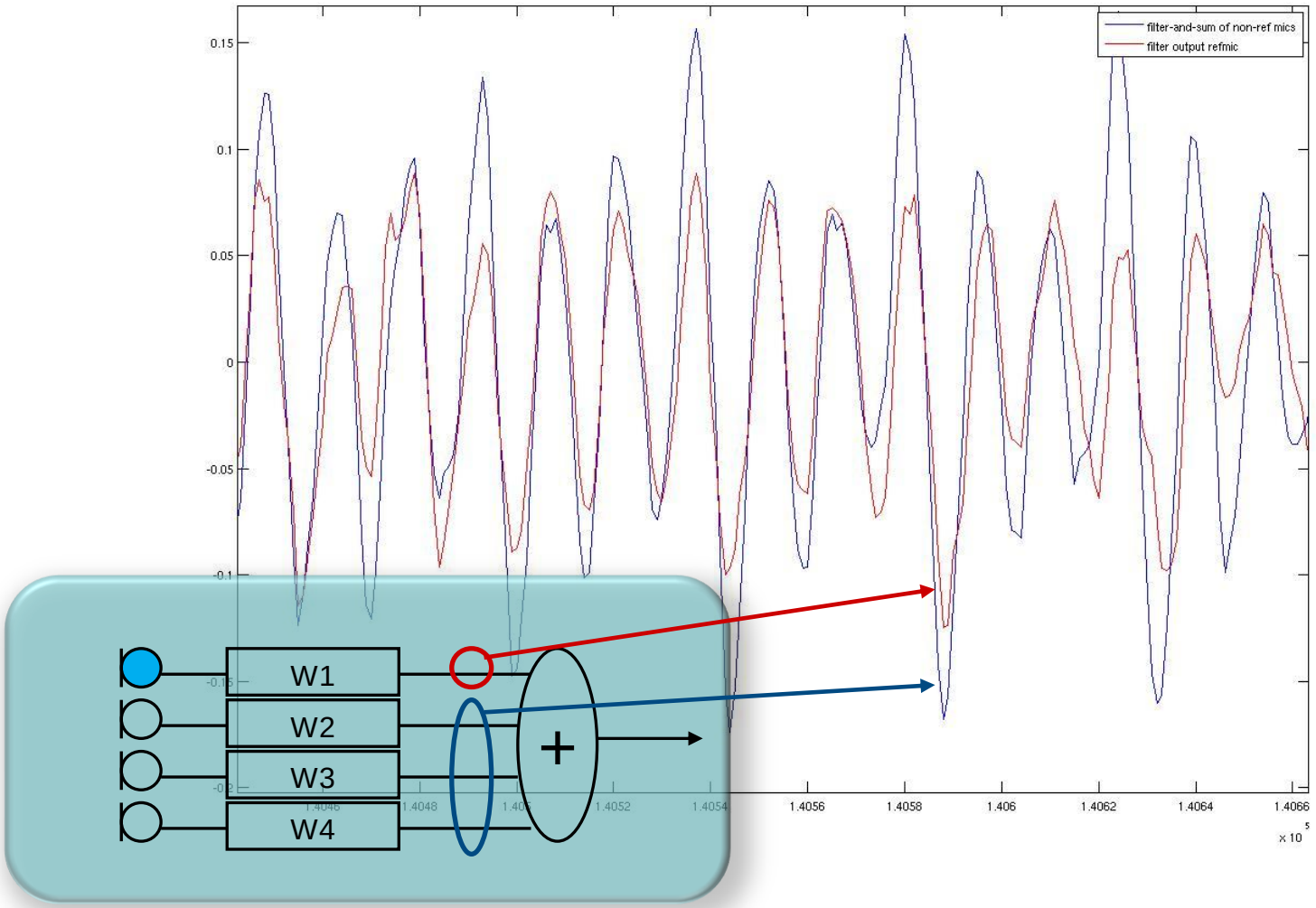
Optimal noise reduction filters can be computed, purely based on **observed cross-correlations**

→Source and microphone positions are unknown!

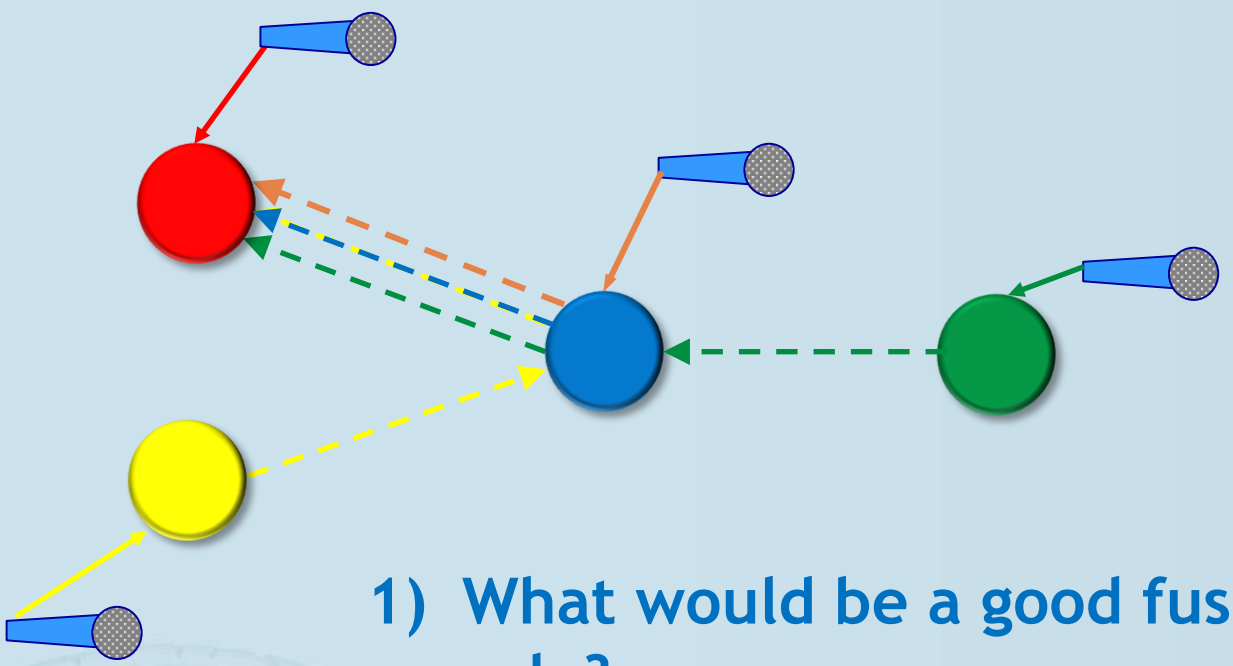
Noise segment: destructive interference

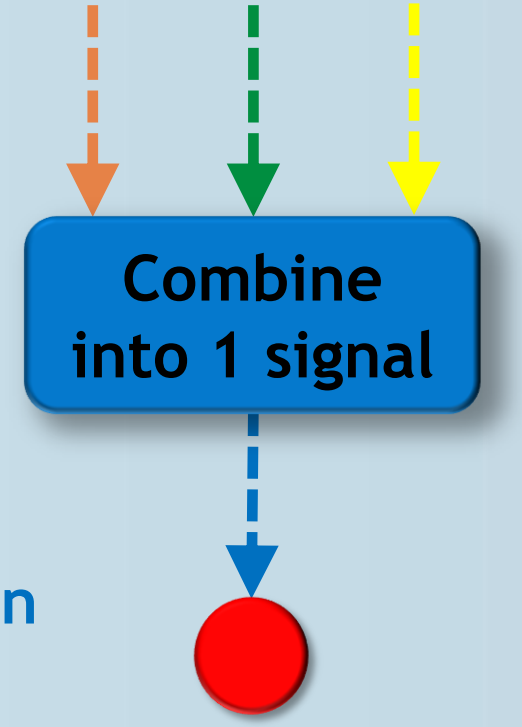


Speech segment: constructive interference



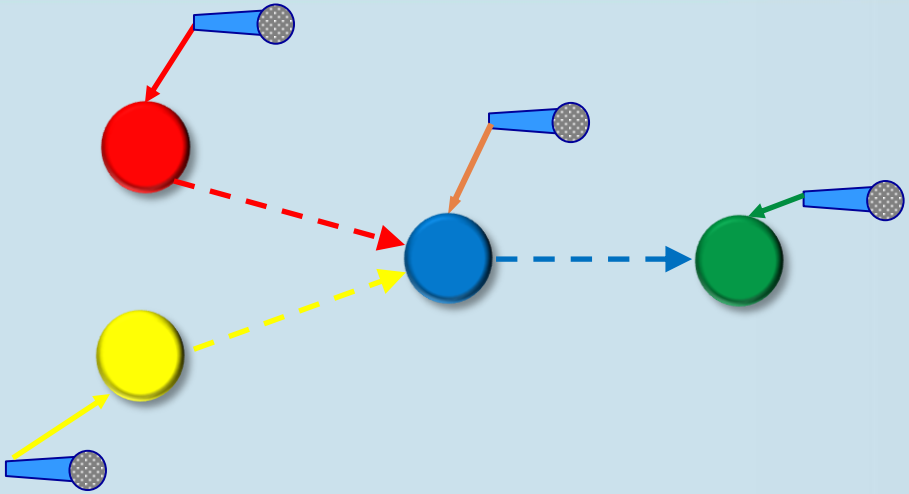
In-network signal fusion vs. relaying

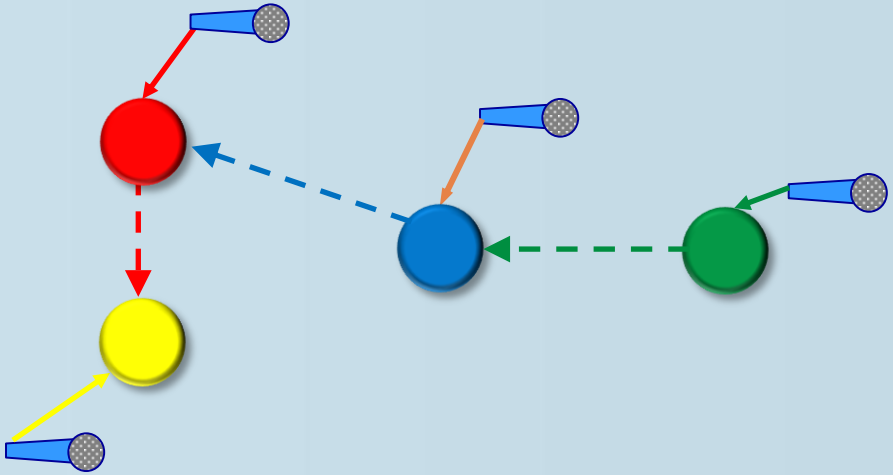




1) What would be a good fusion rule?

In-network signal fusion

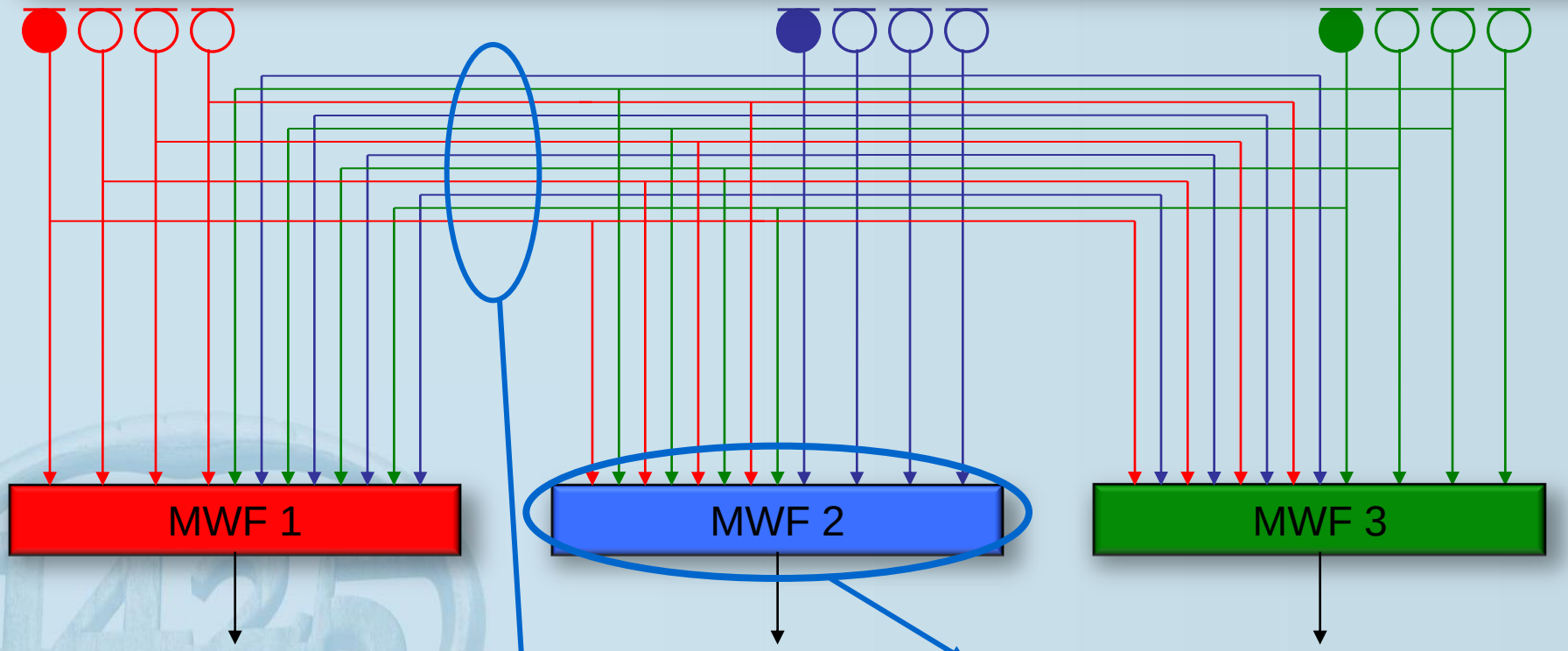




1) What would be a good fusion rule?
2) Different topology may give different performance!

Example: DANSE with 3 cluster heads

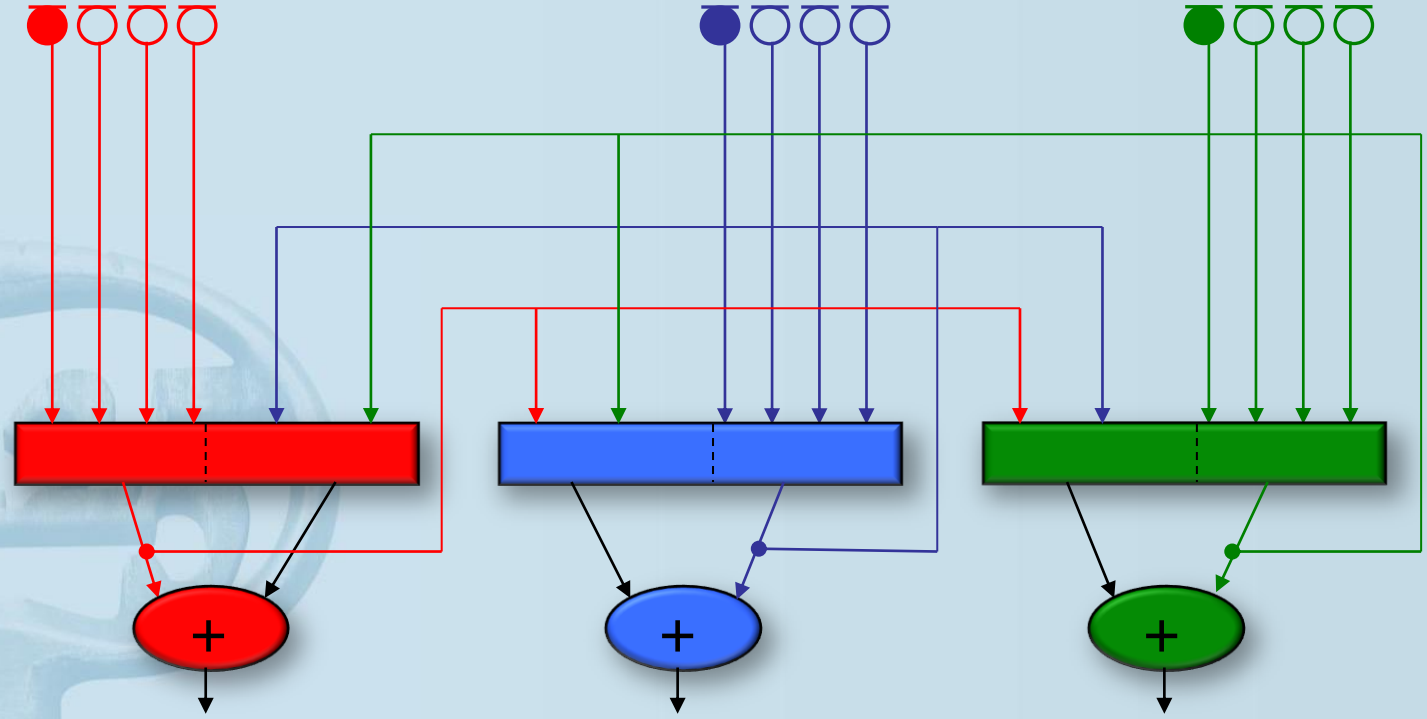
How to obtain optimal noise reduction without transmitting all microphone signals ?



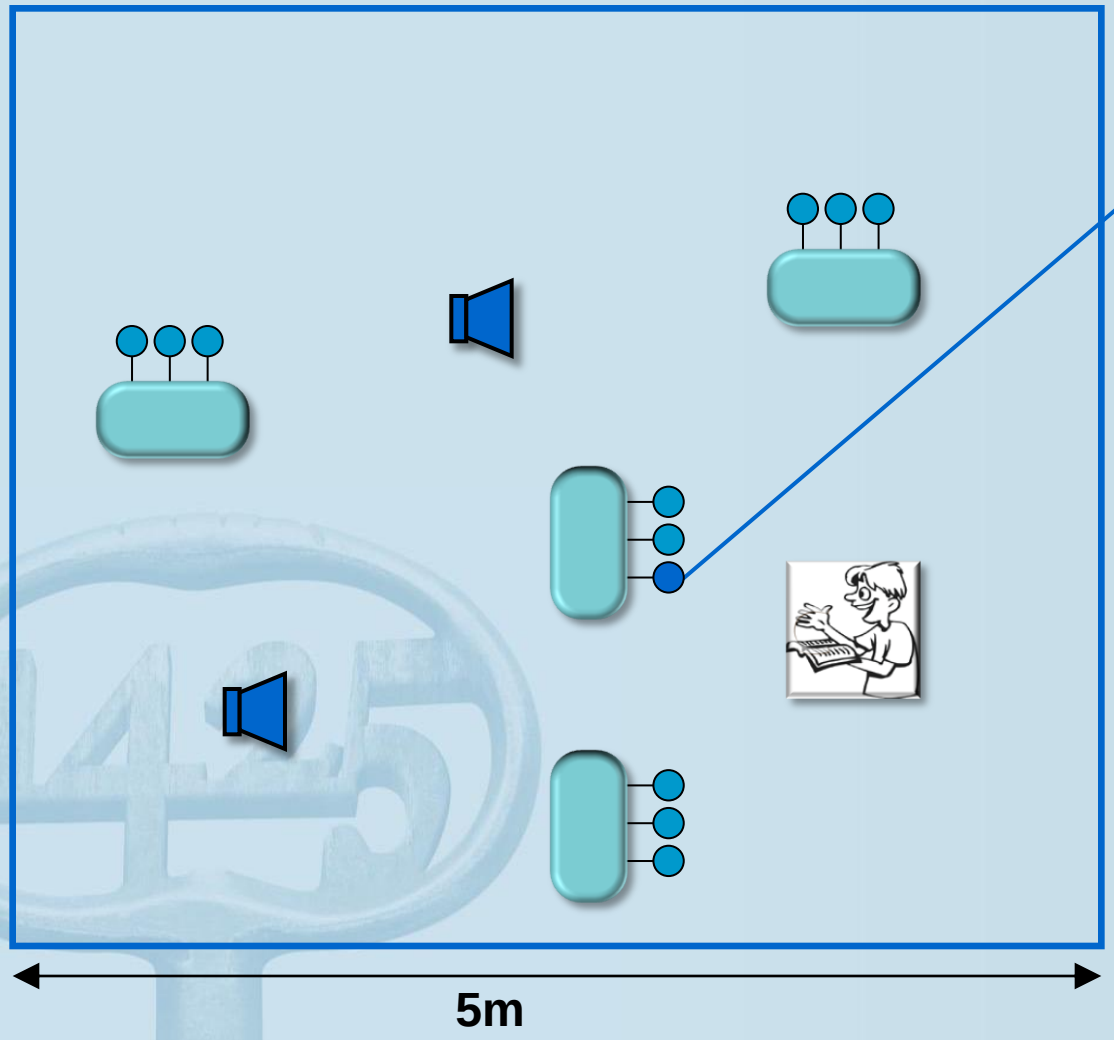
Example: DANSE with 3 cluster heads

Converges to optimal noise reduction **as if all nodes have access to all microphones**

(similar results for arbitrary **tree topology**)



Simulation results

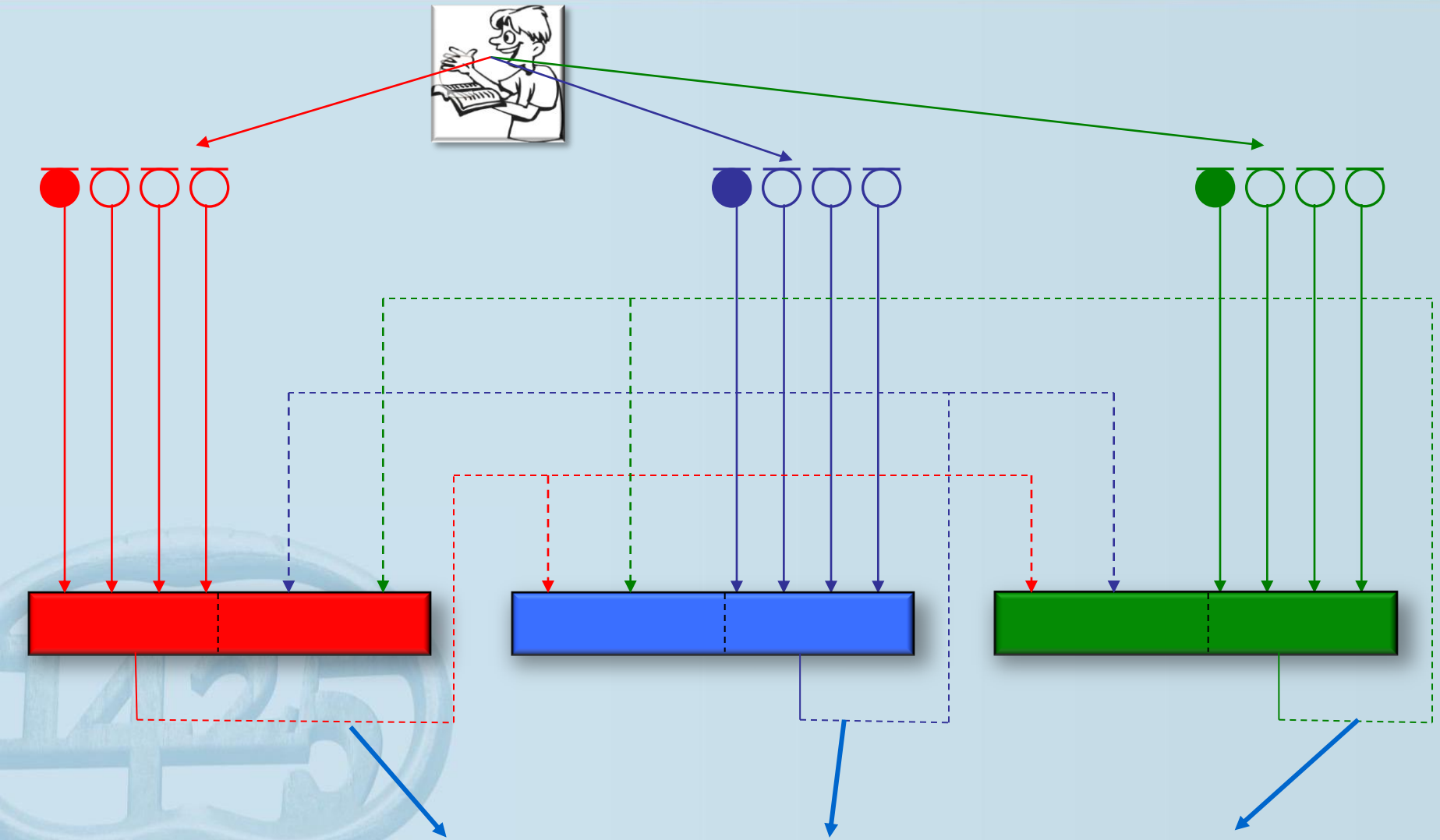


Input

Centralized SDW-MWF (adaptive, after convergence)

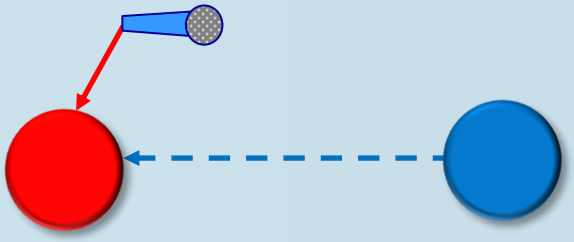
rS-DANSE (adaptive, after convergence)

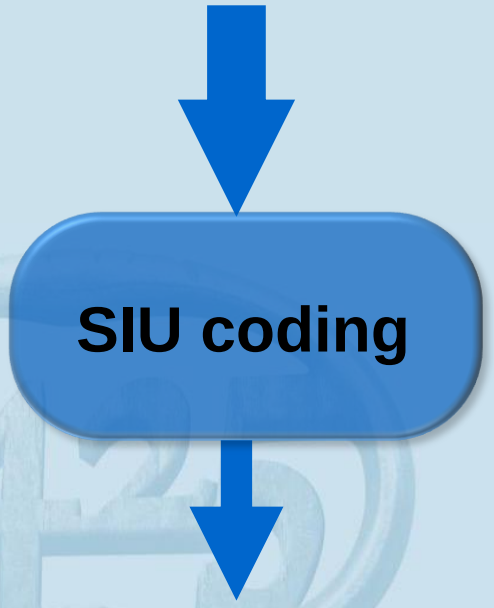
Example: DANSE with 3 cluster heads

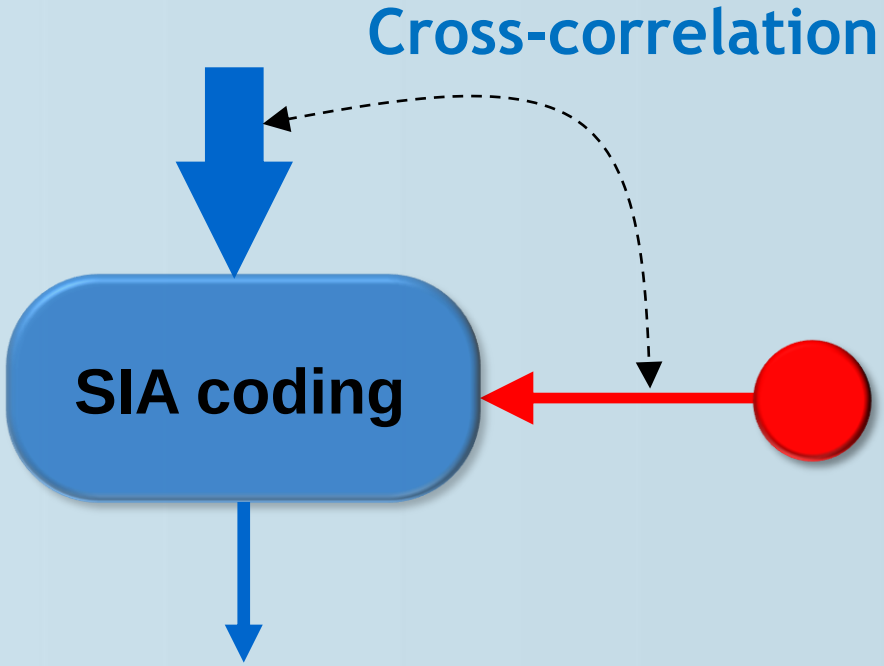


Further data reduction: transmitted signals need to be encoded

Side-information aware (SIA) coding







Thank you