University of Liège

Faculty of applied sciences - Institute Montefiore

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Master Thesis Defense

Mobile device power management for load flexibility: frequency dynamics and introduction to software aspects

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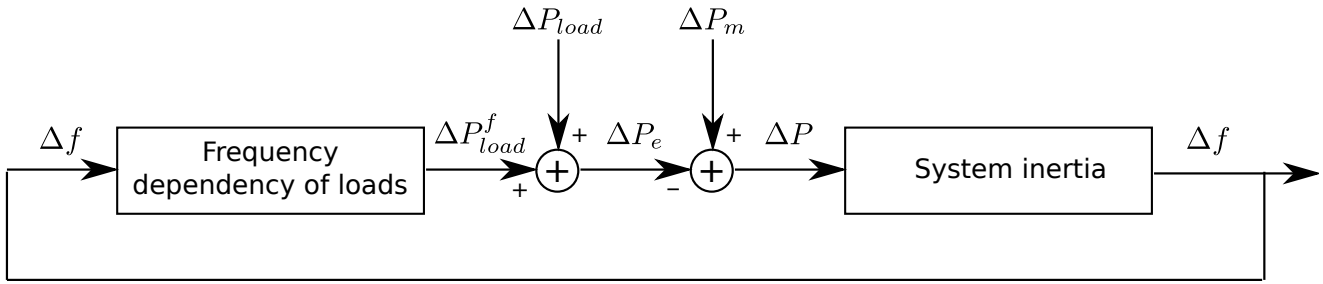
Introduction

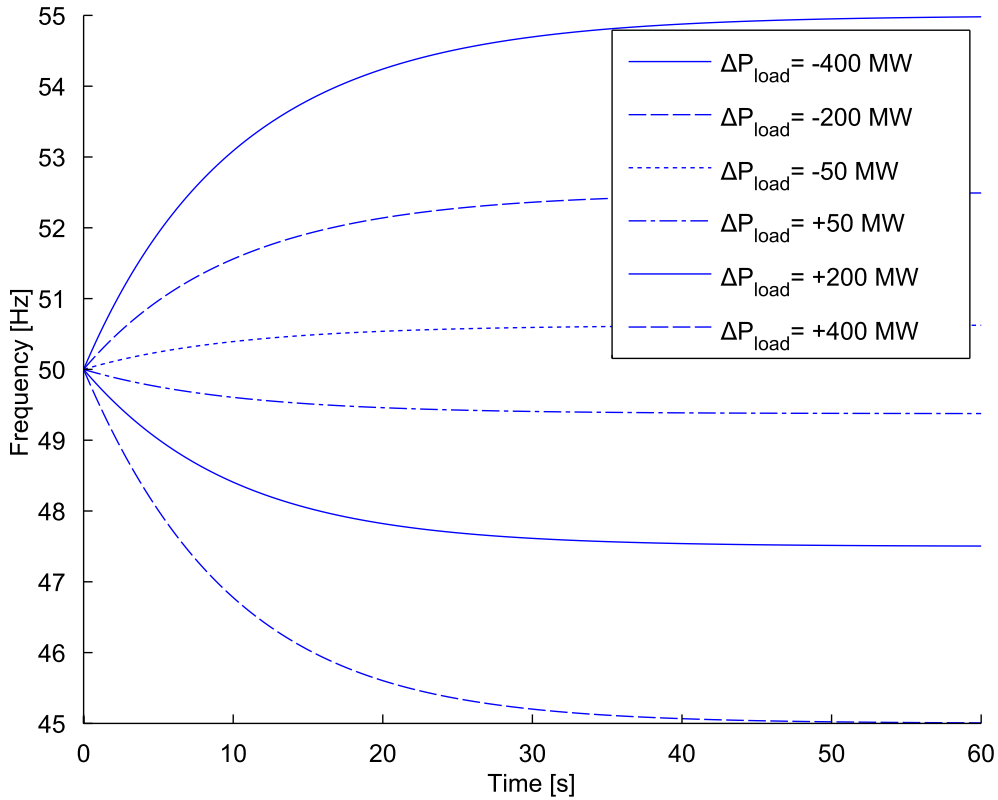
- Context
  - smart grid approach
  - renewable energy increasing
  - energy and climate policy
- Purpose
  - frequency dynamics
  - primary reserve for frequency regulation
  - MODEPOMA concept: load flexibility

Uncontrolled power system



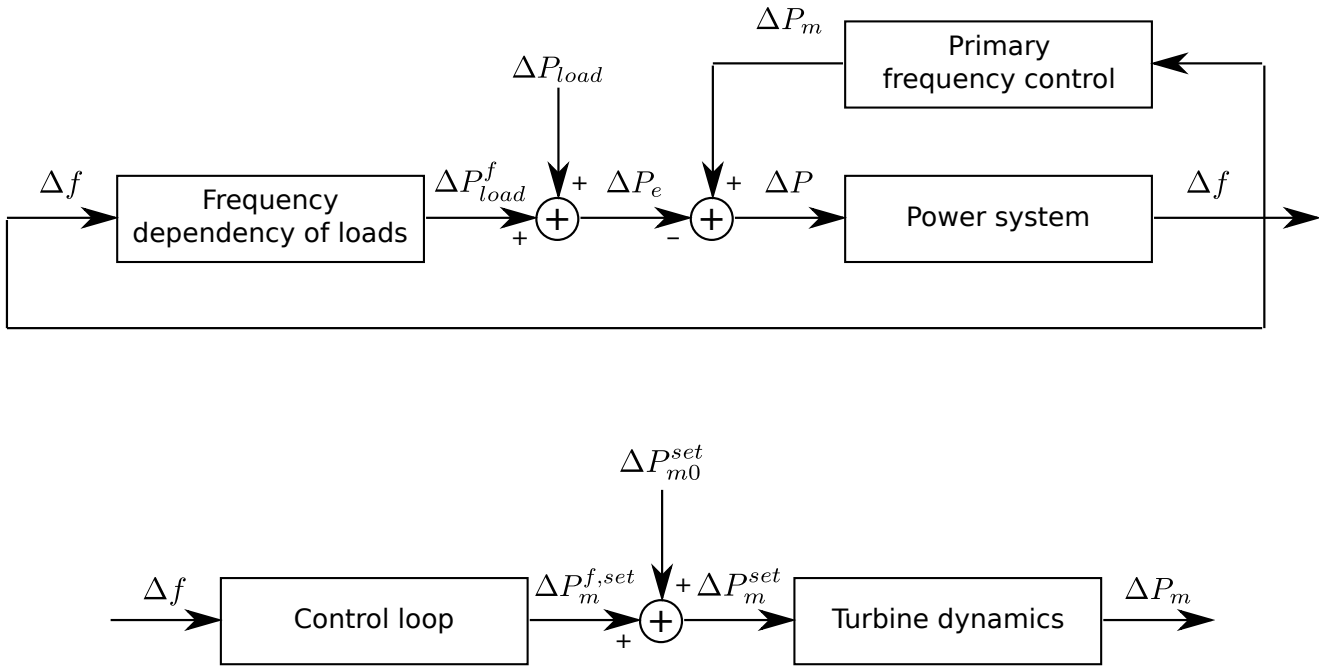
- Power imbalance $\Rightarrow$ frequency deviation

Uncontrolled power system



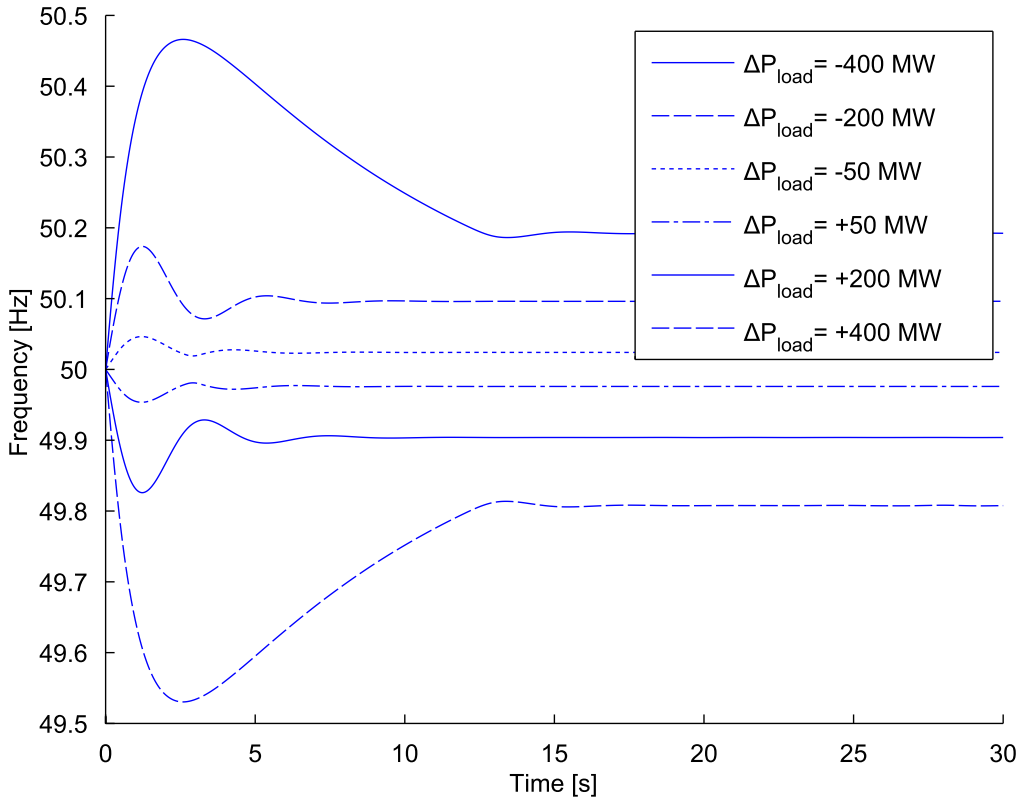
- Need a frequency regulation

Primary frequency control



- Aims to stabilize the frequency with a reduced frequency deviation
- P-controller usually used

Primary frequency control



- Reaches the objective
- Always asymptotically stable

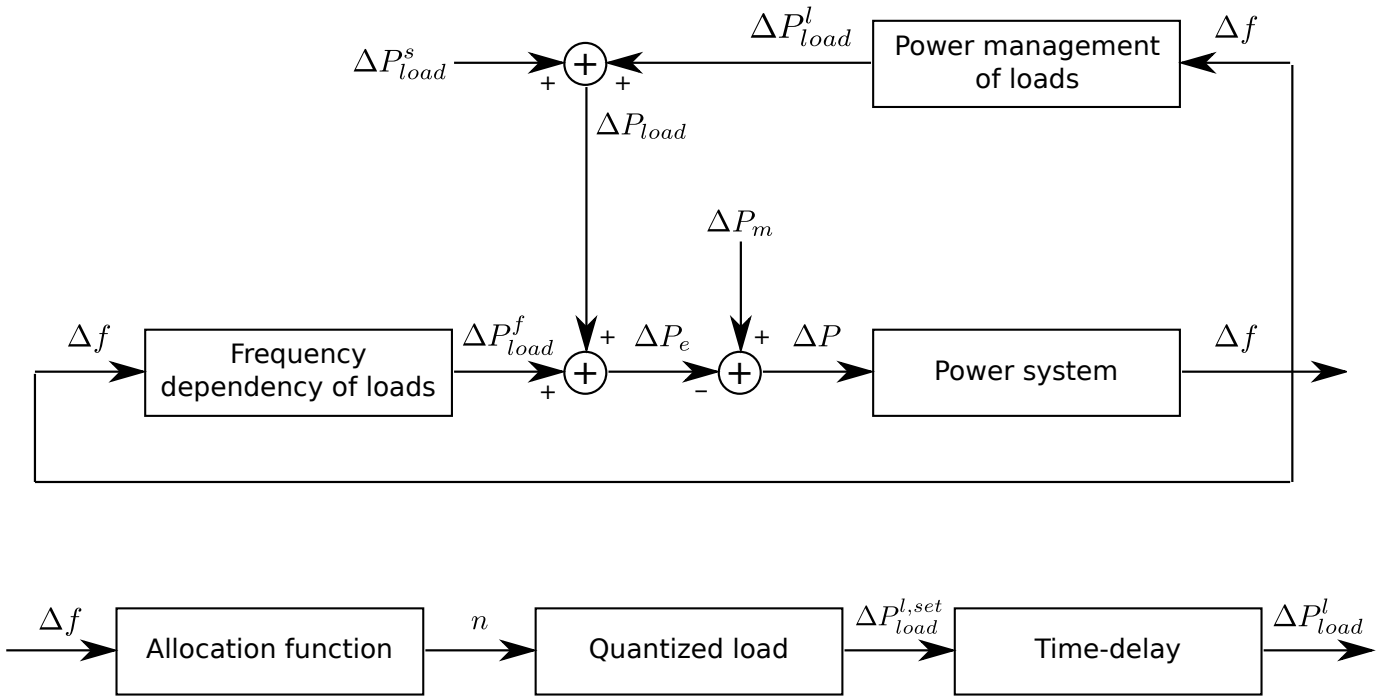
Primary frequency control

- Controller's parameters:
  - the time constant of the turbine τ_t
    - $\rightarrow$ the activation speed of the primary reserve
  - the speed droop characteristic S
    - $\rightarrow$ the available primary reserve

$\Rightarrow$ Intrinsic features

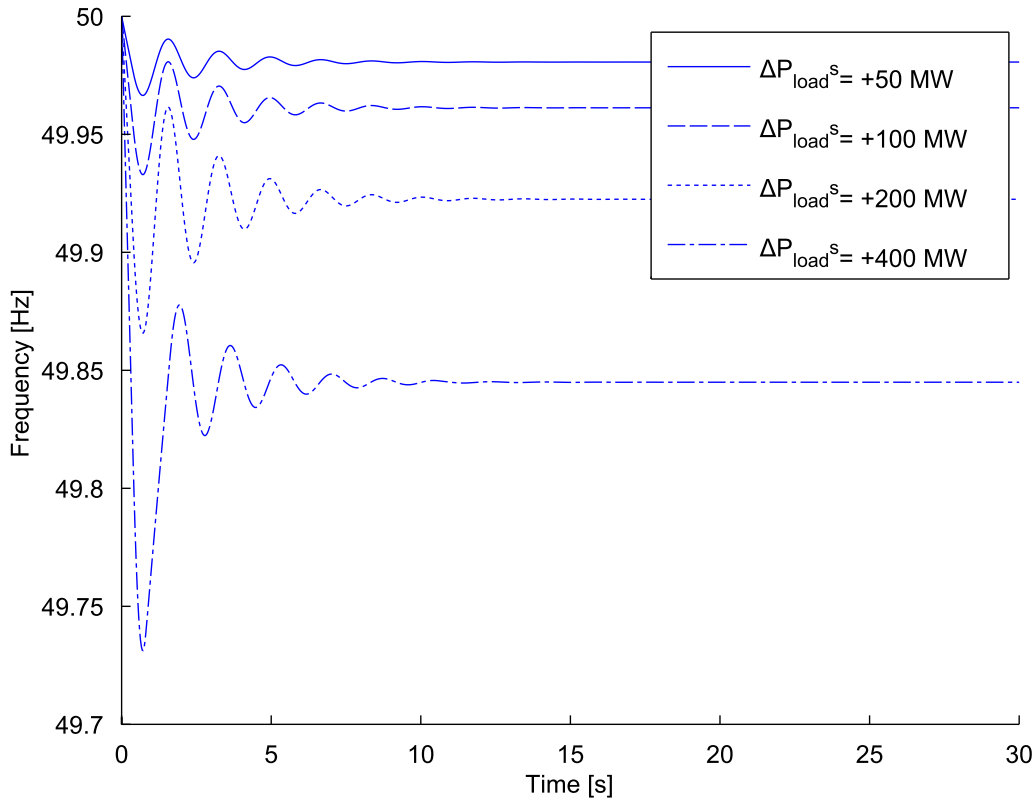
$\Rightarrow$ Performance limited by its own implementation

Power management of loads



- Aims to stop the frequency drop
- Consider a P-controller

Power management of loads



- Reaches the objective
- Not always asymptotically stable: possibility to prevent oscillations

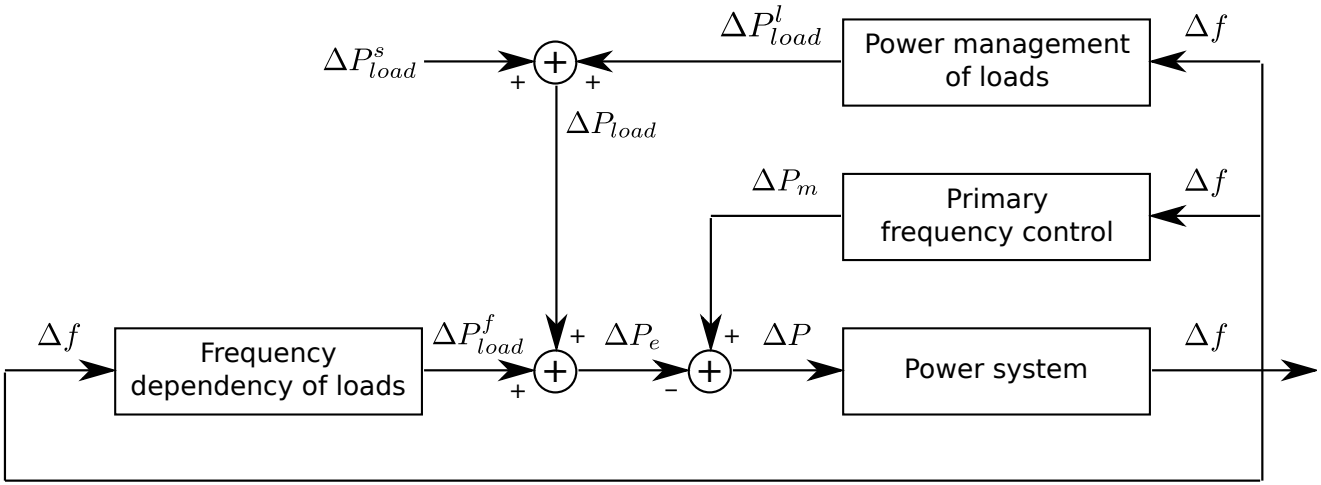
Power management of loads

- Controller's parameters:
  - the frequency deviation for full activation Δf_{min}
  - the number of available quantized loads N_0
  - the quantized load q
    - $\rightarrow$ the available primary reserve
  - the time-delay τ
    - $\rightarrow$ the lag introduced in the power system

$\Rightarrow$ Correlation with the primary frequency control

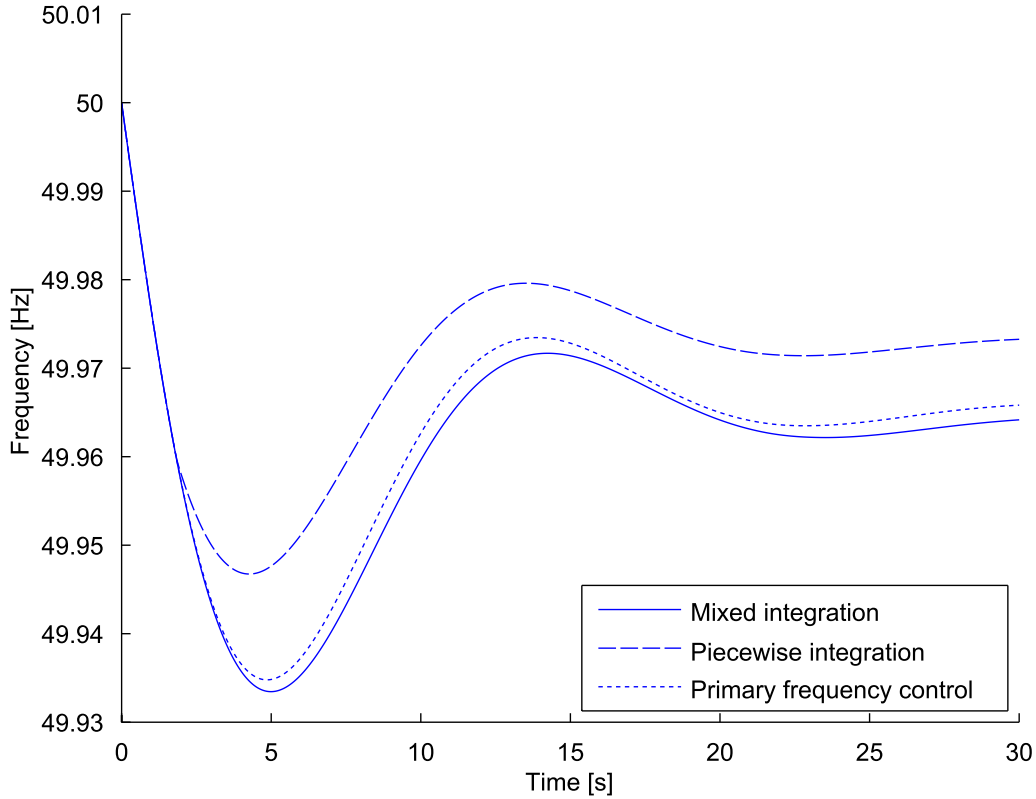
$\Rightarrow$ Relatively adjustable parameters

Transmission System Operator's perspective



- Limitation of current standards
- Integrations:
  - the mixed integration: respect current standards
  - the piecewise integration: take advantage of the power management of loads

Transmission System Operator's perspective



- Compared to the primary frequency control:
  - the mixed integration: less efficient
  - the piecewise integration: more efficient even with a smaller size global primary reserve

Introduction to software aspects

- Requirements to a software support: an IT platform
  - Assumptions and purpose
  - Constraints
  - Actors
  - Use cases

Conclusion

- Overview on what already exists
- Introduction of the MODEPOMA concept
  - model the power management of loads
- Integration of our idea in the current context
  - the piecewise integration efficiently works
- Next step: the implementation

Thank you for your attention