A Two-layer Distributed Secondary Control Scheme for **Microgrid Systems**

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In a microgrid (MG) system energy resources are often dispersed over the network. Traditional centralised controller scheme to control such distributed energy resources are typically expensive to operated on a computation and communication standpoint. These centralised controllers suffer from single-point of failure and do not support 'plug-andplay' requirements. It is thus natural to apply a distributed control structure to the MG system.

In a distributed control scheme communication scheme, each controller communicates its local information with its neighbouring controller. The communication setup can be flexibly configured to ensure a high resiliency against single communication failure.



Distributed Control Scheme

Examples of typical centralised secondary control functions which can be achieved using a distributed control scheme:

- Frequency and voltage restoration
- Active and reactive power sharing
- Voltage quality enhancement
- Economic dispatch
- Optimal power flow
- **Economic Dispatch in MG system**

dispatch aims to Economic allocate the power output among dispatch-able generators at lowest generation cost while meeting global power balance

 $\min_{P} \sum_{k \in DG} f_{DG,k}(P_{DG,k}) + \sum_{j \in ESS} f_{ESS,j}(P_{ESS,j}) + f_{UG}(P_{UG})$ s.t. $\sum_{k \in DG} P_{DG,k} + \sum_{j \in ESS} P_{ESS,j} + P_{UG} + P_{RG} = P_D + P_L$ and (2), (4)



Agent-based Distributed Economic Dispatch Scheme



Distributed λ -Iteration Algorithm is applied to achieve economic dispatch of available DERs. When the grid is connected, utility price is also shared by applying FACA in a distributed manner, to obtain economic power allocation.



Distributed λ-Iteration Algorithm



Proposed Distributed λ -Iteration Algorithm is able to converge faster than the interior point method with similar results

Algorithm	P_1	P_2	P_3	P_4	P_5	Total Cost	Iteration
	[MW]	[MW]	[MW]	[MW]	[MW]	[\$]	Step
Proposed	1.7110	1.0266	1.4664	0.4000	0.3960	760.2559	16
Ipopt	1.7100	1.0275	1.4661	0.4000	0.3964	760.2582	28

- 1) Total power demand discovery
 - FACA is used to obtain total network demand
- 2) Economic power allocation

FACA is applied to obtain each DER power output



