## A. Model Decomposition

Split by boundary overlap method with tie-lines between regions as boundaries. Taking the two-region network as an example, the variable decomposition mechanism of boundary coupling between area is given in the Fig.1 the tie-line between the two areas are cut between the area, and then add two virtual nodes into the tie-line. Eq.(1) represent Consistency boundary coupling factor.

 (1)



**Fig. 1.** Decoupling mechanism of multi-area IEGN

## B. Fully Distributed Two-stage Scheduling Model and Solution Based on S-ADMM

Standard ADMM can be implemented for a multi-agent optimization problem, which is in accordance with the scheduling problem of a multi-area IEGN described above. But it has the characteristic of slow iteration and tough to converge. Taking two area of IEGN as an example, the augmented Lagrange function, algorithm iteration format and corresponding constraints of region A and B are given as fol-lows:

 (2)

 (3)

Whereandrepresents the reference values of the boundary coupling variables of regions *A* and *B*, respectively, which are calculated as(4),and the coordination among subsystems is achieved by updating Lagrange multipliers. The updating process is given in(5).

 (4)

 (5)

Each subsystem calculates its regional sub-problem with updated Lagrange multi-pliers. The whole decentralized algorithm terminates when all coupling variables perceived by their connected subsystems are close enough.

The solution procedure of the S-ADMM is given in Fig. 2 and described as follows.



**Fig. 2.** Flowchart of the decentralized operation by S-ADMM

Specifically, the steps for solving the decentralized two-stage stochastic optimization model built in this paper are as follows.

***Setp1*:**Initialize values of shard information，Based on the scenario method, wind power forecast scenarios and error scenario values are independently are generated for each region;

***Setp2:*** Set the number of iterations =1, and initialize the S- ADMM related algorithm parameters 、and 、;

***Setp3:*** Solve the two-stage stochastic optimization model of each region independently, and perform the iterative process of improving successive linearization for the inner layer, until the end of the inner layer iteration, and then perform the S-ADMM iterative process for the outer layer;

***Setp4:*** Each subsystem checks if its convergence residuals are with in tolerances:



If yes, the ADMM procedure ends. Otherwise, each area updates it coupled variable and multipliers by(4)-(5).

***Setp5:*** Set =+1.Each area repeats steps2 until the stopping criteria are met.