Seminar on
African Electrical Interconnection

# Module 7 - Market Operational Structures

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*Contents*

1) Power Market Principles
2) Major Operational Issues
3) Transmission System Operator
4) Open Market Model
5) Ancillary Services
6) Transmission Pricing
7) Inter-area Coordination
8) The Concept of RTO

# Module 7 - Market Operational Structures

***Highlights***

- **Rationale for a restructured power sector** creating an open competitive market environment for generation
- Necessity of ensuring **market efficiency**
- Strategic importance of the **transmission system operator**
- Imperative need to perform complex functions required by **strict reliability requirements**

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# Power Market Principles

**Well managed reform of the power sector**

**Deregulation to foster a competitive open market**

Enhance power supply reliability

Improve market efficiency

Add value to all participants

Provides incentives for investments and expansion

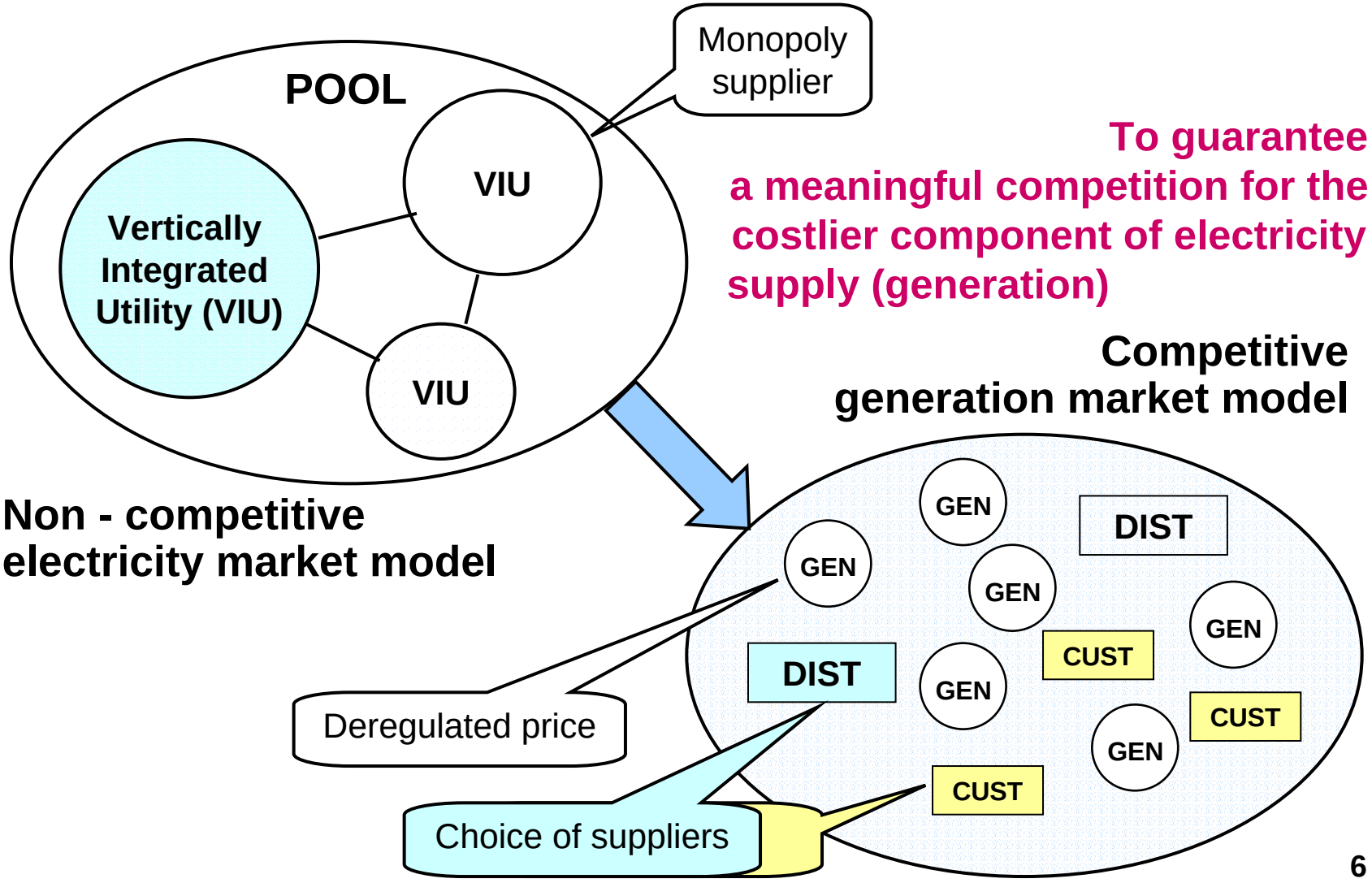
Facilitates the involvement of international investors

**Supports the implementation of RECI**

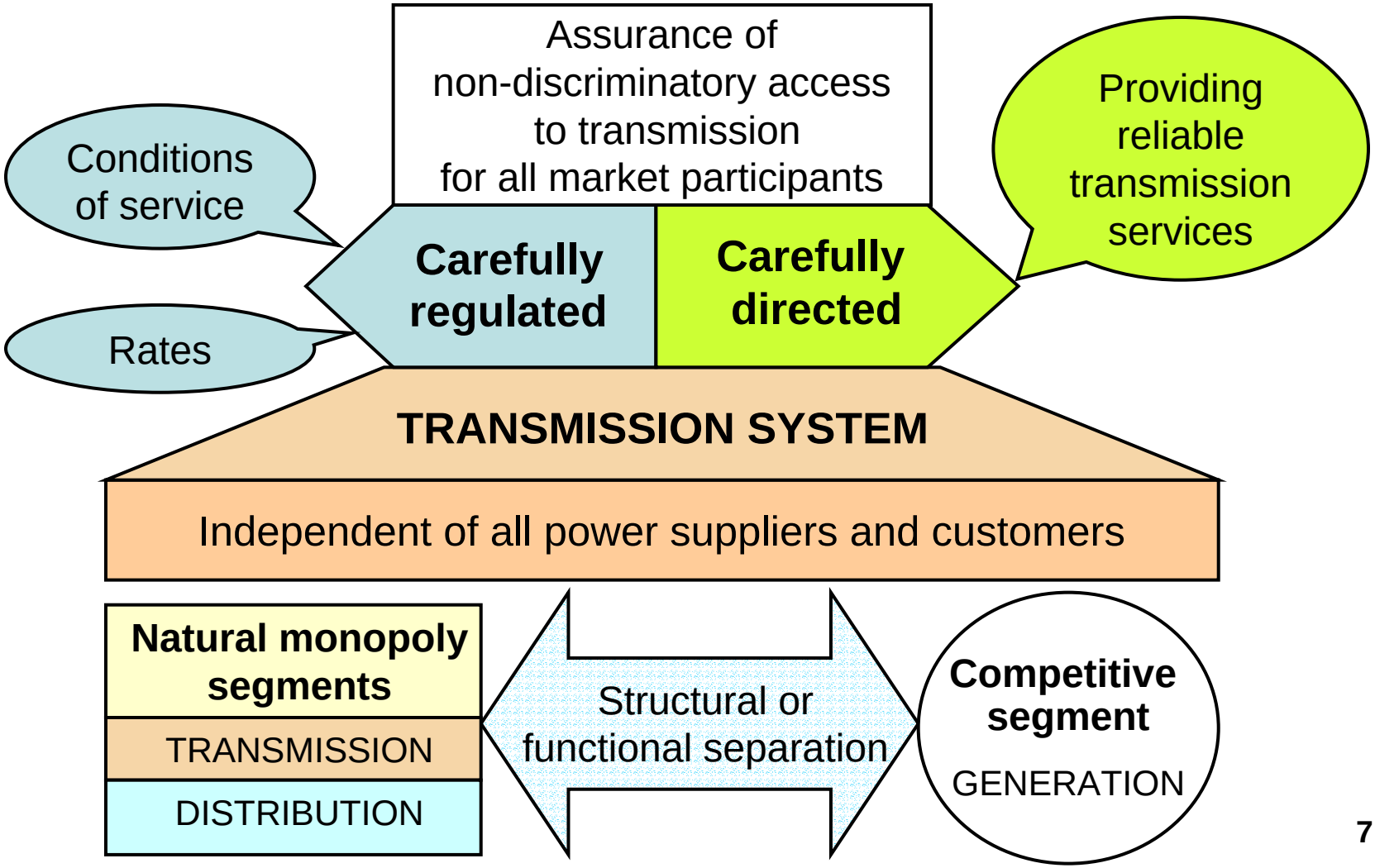
**Production of electricity can be deregulated**

Not a monopolistic type of service

# A Worldwide Trend towards Deregulation



# To Guarantee a Meaningful Competition



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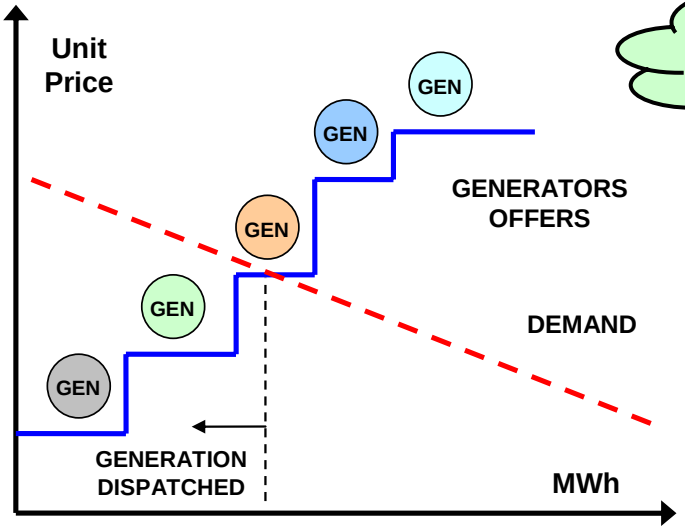
# Conditions for an Efficient Market

## Key elements for a successful RECI

Availability and optimal **dispatch of the most efficient production sources** throughout the region




Capable of coordinating the suitable use of the transmission system

Safe and reliable operation

**TRANSMISSION SYSTEM OPERATOR**

To meet power transfer requirements

Major issues

Mechanisms for real-time selection of production sources
Access to the transmission system
Transmission fees

# Market - Oriented Issues

- Organization and allocation of **governance and regulation** between government (through the **Regulator**) and industry
- The existence and characteristics of a bilateral and/or a centrally administered **market for capacity**
- Conditions governing the **energy market** and the mechanisms to implement the offers/bids principle
- **Coordination of regional trade** and harmonization of rules among neighboring power systems

# Transmission - Oriented Issues

- **Transmission access and pricing methodology** for transmission service and payment for networks reinforcements and expansion
- **Management of congestion** and handling of payment and hedging to mitigate risk
- **Coordination and harmonization of technical operating rules** among neighboring systems
- Management of **ancillary services**

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# Types of Transmission System Operator (TSO)

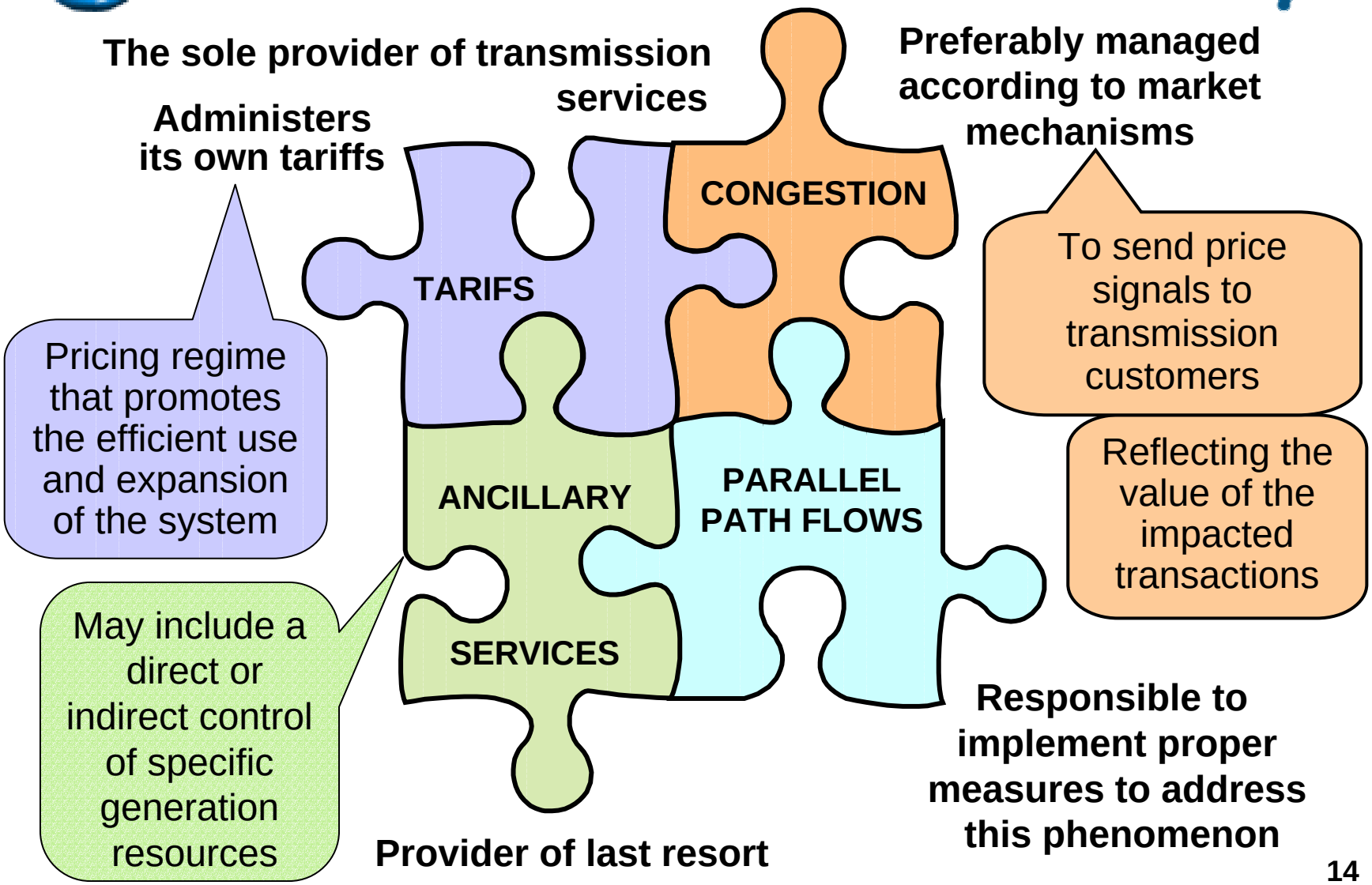
## ISO (Independent System Operator)

- Entity that operates and controls the transmission assets on behalf of all transmission owners
- Easier to form and to accommodate new participants
- Requires a less rigorous regulatory process
  - ➢ No possibility of conflicts of interest due to ownership of transmission assets

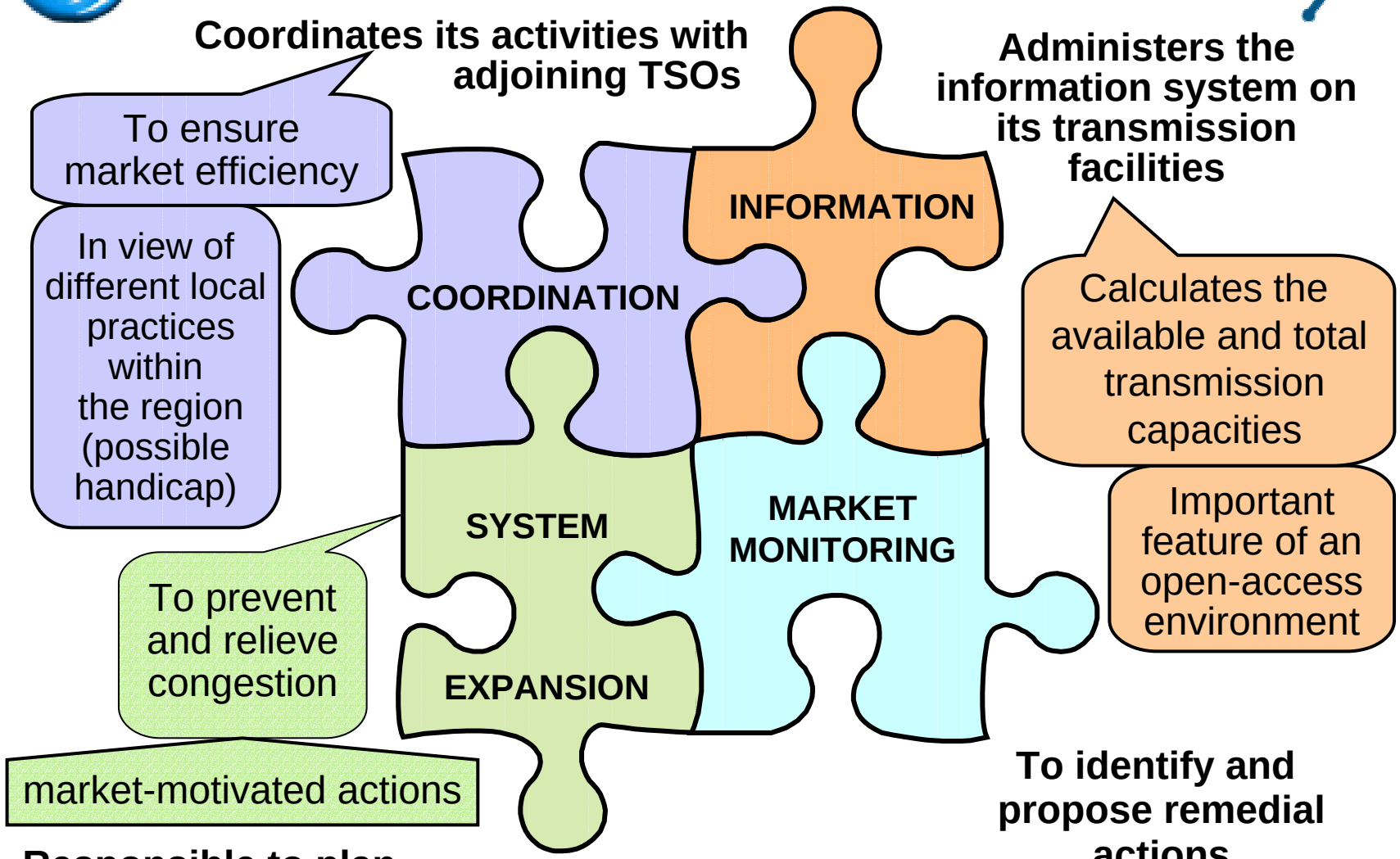
## Transco (Transmission company)

- Entity that owns or leases the transmission assets
- Likely to be more efficient and easier to operate
  - ➢ Financial interest may be an incentive for efficiency
- Simplifies rate-making

# TSO Major Functions



# TSO Major Functions



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# Market Participants - Responsibilities and Obligations

## Transmission System Operator (TSO)

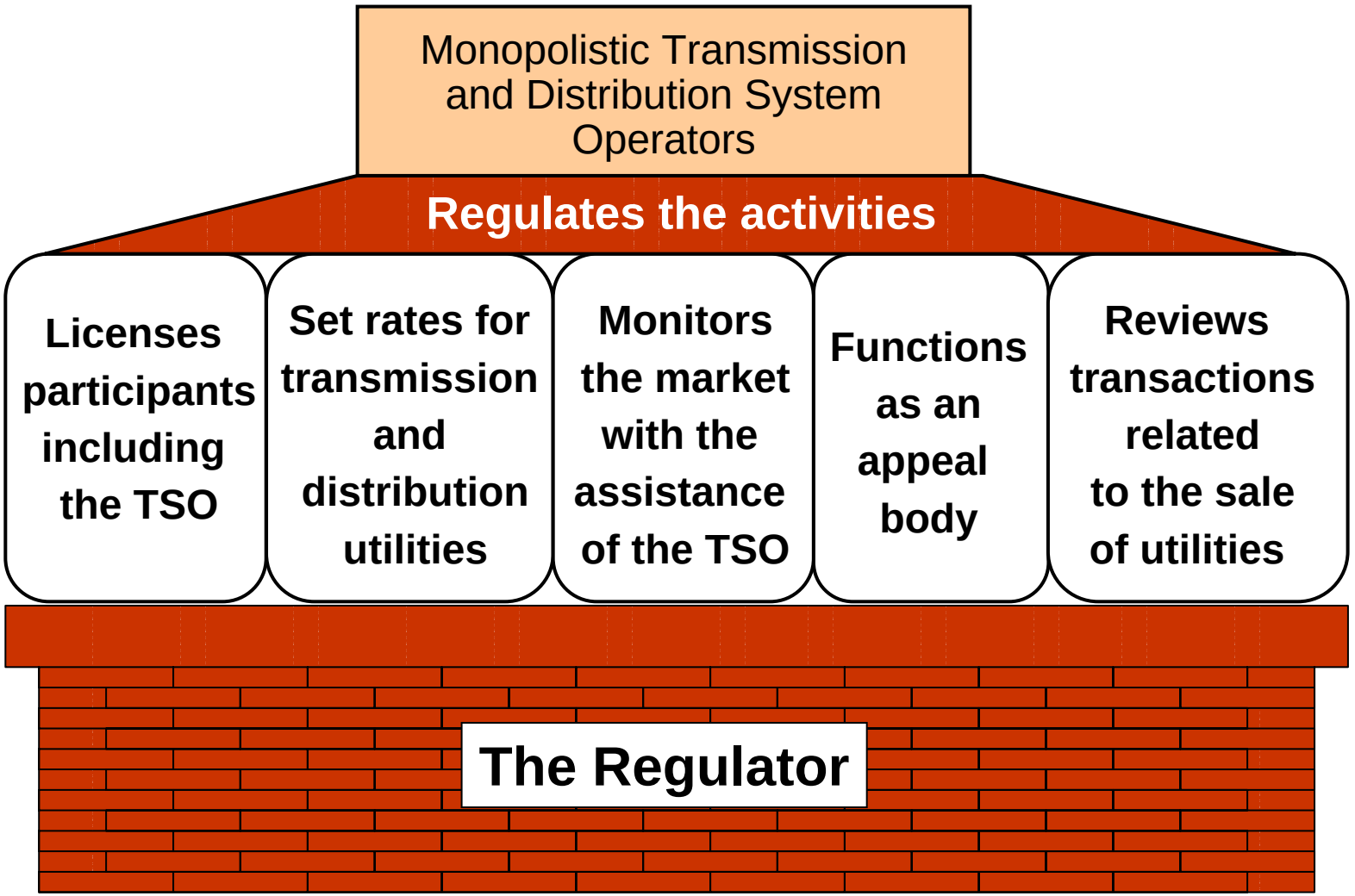
- Maintains and directs the operation of a reliable and cost-effective transmission system

## Licensed participants

**Generators, Distributors, Transmission assets owners, Wholesale buyers and sellers, Retailers**

- Comply with the TSO directions and enter into connection agreements
- Operate and maintain their equipment according to the TSO reliability standards
- Participate in the capacity, energy and ancillary services markets

# The Regulator – A Key Player



# Open Market Main Features

- **Non-discriminatory access** to transmission and distribution systems
- **Existence of a TSO** responsible for transmission over a significantly large area
- **Efficient** generation dispatch mechanisms
- **Visible and transparent** market clearing prices paid to all participants
- **Independent** Regulator for approval of transmission service rates

# Types of Transactions

Between licensed participants

1) **Bilateral contracts between buyers and sellers**
2) **Transactions through the markets**
   - Real-time spot electricity market
   - Ancillary services procurement market

## 1) Physical bilateral contracts

Involve direct commercial arrangements between market participants

- No obligation to inform the other participants of their settlement price
- Directly paid by the buyers at a predetermined price

# Spot Market Price

## 2) Transactions through the markets

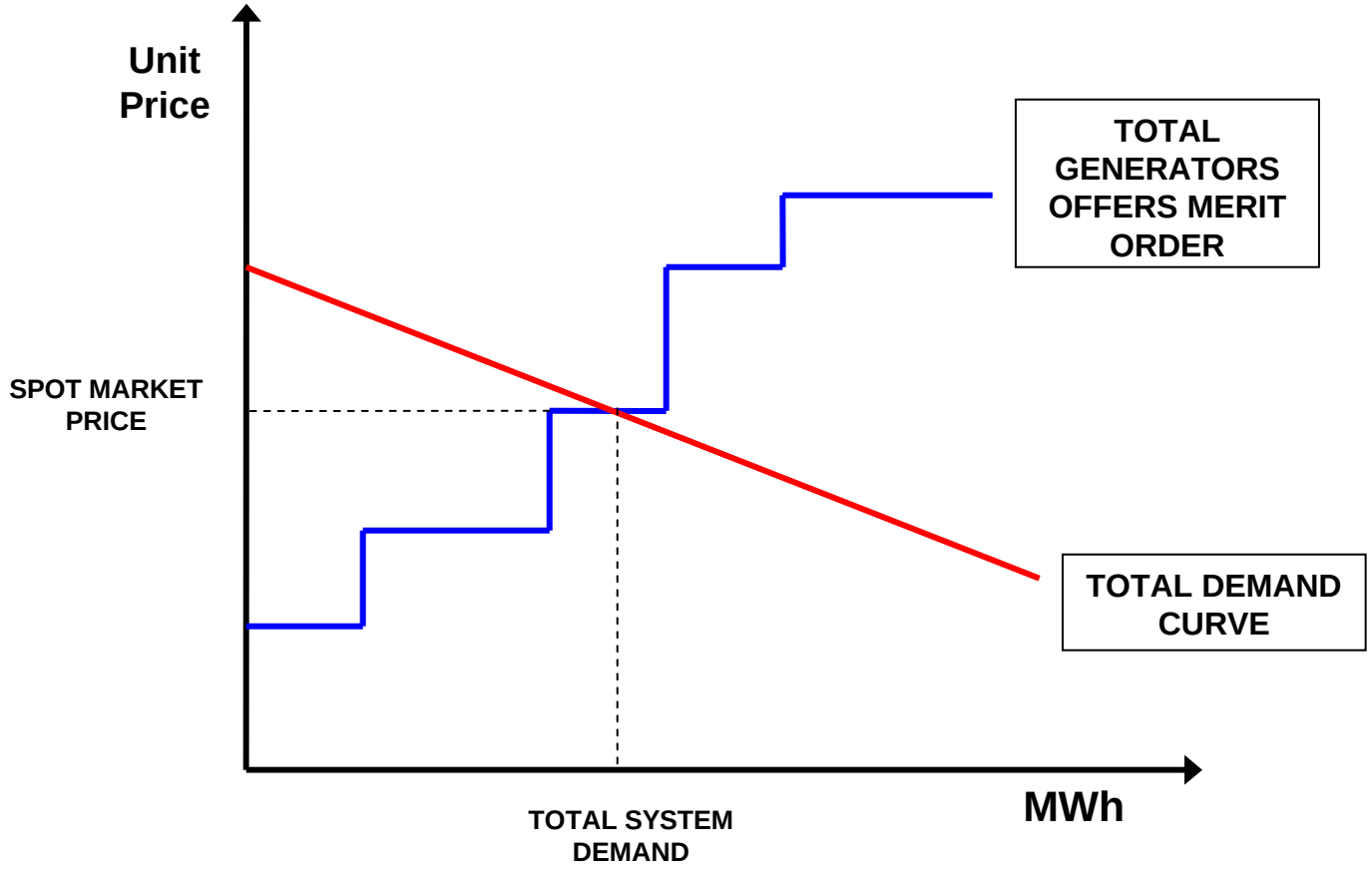
Involve a market mechanism that results in a clearing price for the additional supply to meet **demand beyond the bilateral contracts**

**Established by the market**, at the intersection point of the generator offers supply curve and the demand curve

- **Offers:** quantity of power vs. price (fixed for one hour)
- **Demand:** adjusted every five minutes

- All generators are paid the market price whatever their offer
- **Does not apply to physical bilateral contracts**

# Spot Market Equilibrium Price



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# Managing Ancillary Services

## Interconnected Operations Services

- **For the proper integrated functioning of generation and transmission**
  - Essential to maintain frequency, voltage and reliability within prescribed levels while meeting customer demands
- **Must be coordinated on a system-wide basis**
  - **Must be managed by the Transmission System Operator**
  - More easily acquired through a central market mechanism
- Eleven ancillary services have been identified
  - An indication of the complexity of operating a power system

# Six Basic Ancillary Services

**Operating Reserve Spinning**

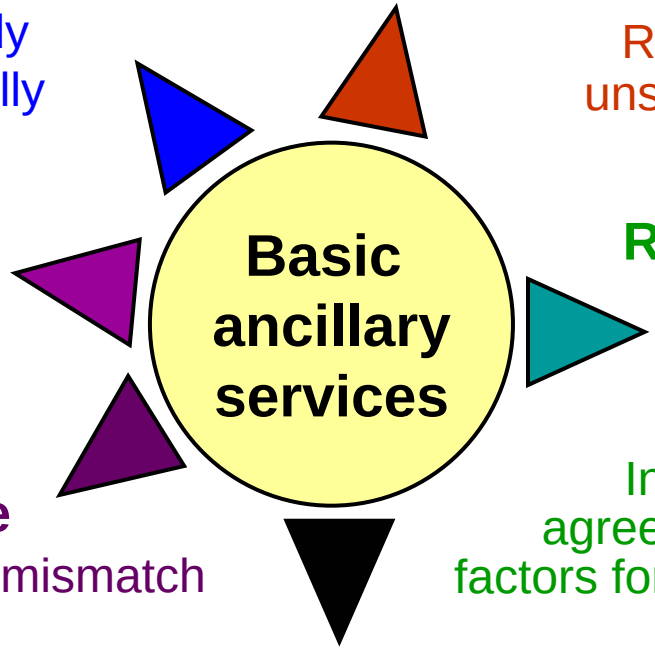
To respond to contingencies

From generators already synchronized but not fully loaded

**Scheduling, System Control and Dispatch**

To implement interchange schedules between **control areas**

Responsible to eliminate unscheduled interchanges (loop or parallel flows)




**Operating Reserve Supplemental**

To be made available within 10 minutes

**Reactive Supply and Voltage Control from Generation Sources**

In addition to connection agreements (required power factors for loads and generation)

**Energy Imbalance**

To compensate for the mismatch between a generator's scheduled output and the amount actually provided

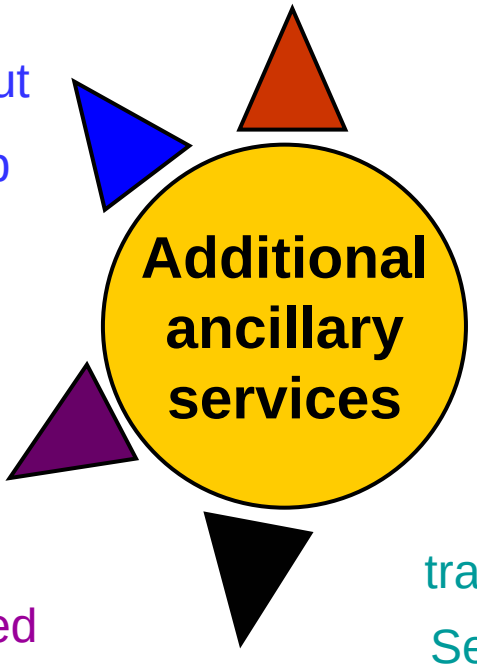
**Regulation**

To balance generation and maintain frequency (minute-to-minute variations)

**Best provided through the real-time bidding markets**

Can involve automatic control signals sent to generation and loads by the TSO

# Five Additional Ancillary Services




## System Black Start Capability

To restart or restore power after a system-wide blackout

From units that can start up without the assistance of electrical supply from the power system

## Dynamic Schedule

To operate a generator in a host control area as if it were part of another area

Requires the availability of real-time monitoring and telemetering facilities

## Network Stability Services from Generation Sources

To increase power transfer capability or improve transmission system reliability

Separate from the equipment required in the connection agreements

Typically: generation rejection and runback schemes

## Real Power Transmission Losses

To replace energy losses associated with a scheduled bilateral transaction

## Load Following

To provide a load or generation response capability that can be dispatched within a scheduling period

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# Transmission Pricing

## A complex issue due to:

- **The loop flow phenomenon**

➢ The flow of power associated to a supply contract along different, non predetermined, parallel paths and depending on:

- The network status;
- The influence of other transmission service users.

- **The different pricing components**

➢ To properly reflect the costs to be recovered

- Sunk, or past, transmission costs
- Variable transmission costs (losses and congestion)
- New investment recovery costs

# Transmission Pricing Approaches

## 1) Historical cost charging

Reflecting past transmission costs

- **Postage stamp pricing, the simplest**
  - Same unit cost for all, based on total transmission assets
  - Congestion and loss costs charged on a load-ratio basis
- **Contract path pricing**
  - Considering only those assets between producer and consumer
- **MW-km pricing**
  - Assumed to provide a reasonable approximation for transmission cost including losses and congestion

# Transmission Pricing Approaches

## 2) Marginal cost charging

Reflecting more accurately the real incremental cost of specific transmission services

- **Nodal pricing (Locational Marginal Pricing)**
  - Captures a congestion and loss cost which is the price difference between two nodes of the transmission system
- **Incremental cost pricing**
  - Compares total system cost before and after a transaction

# Transmission Pricing Approaches

## The common approach

- A marginal cost formula complemented by a “postage stamp” charge to recover the total revenue requirements
- The cost of new transmission system investments included in the basic use service charge

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# Inter-area Coordination

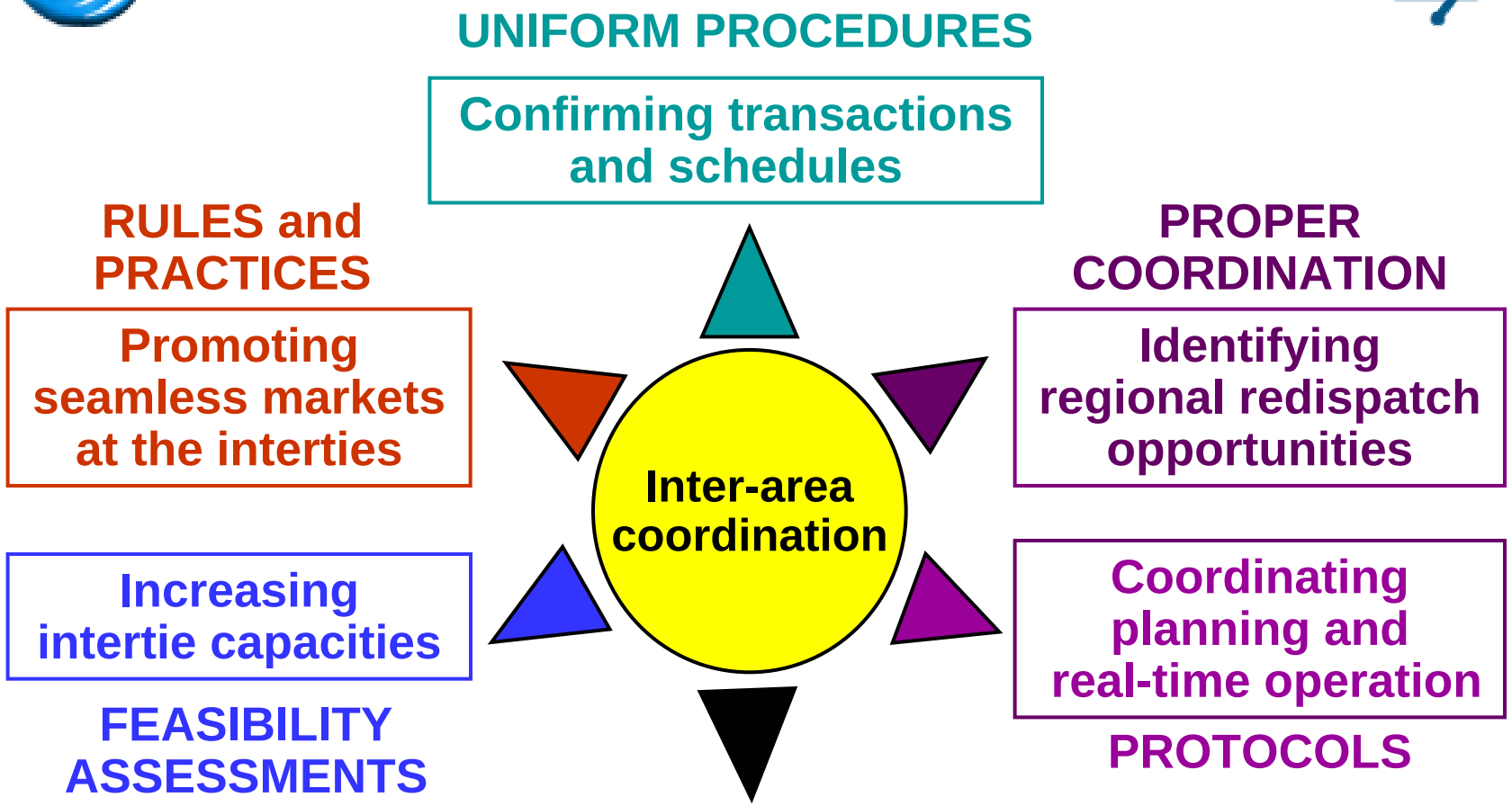
**An important function, aiming at the proper conditions to achieve optimal market operation**

- Refers to the coordination **between control areas**
  - Regardless of their operational structures (ISO, Transco, vertically integrated utilities)

## Control area

- The basic system operating unit
  - Responsible for the supply-demand balance over a geographical area

# Inter-area Coordination Features



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# RTO - Regional Transmission Organization

**An independent transmission organization that maintains the operation of a reliable transmission system on a regional basis**

- Normally covering a region capable of supporting trade patterns in a competitive market
  - Greater efficiency and reliability
  - Enhanced market performance
  - Less opportunities for discrimination

# RTO Operational Authority

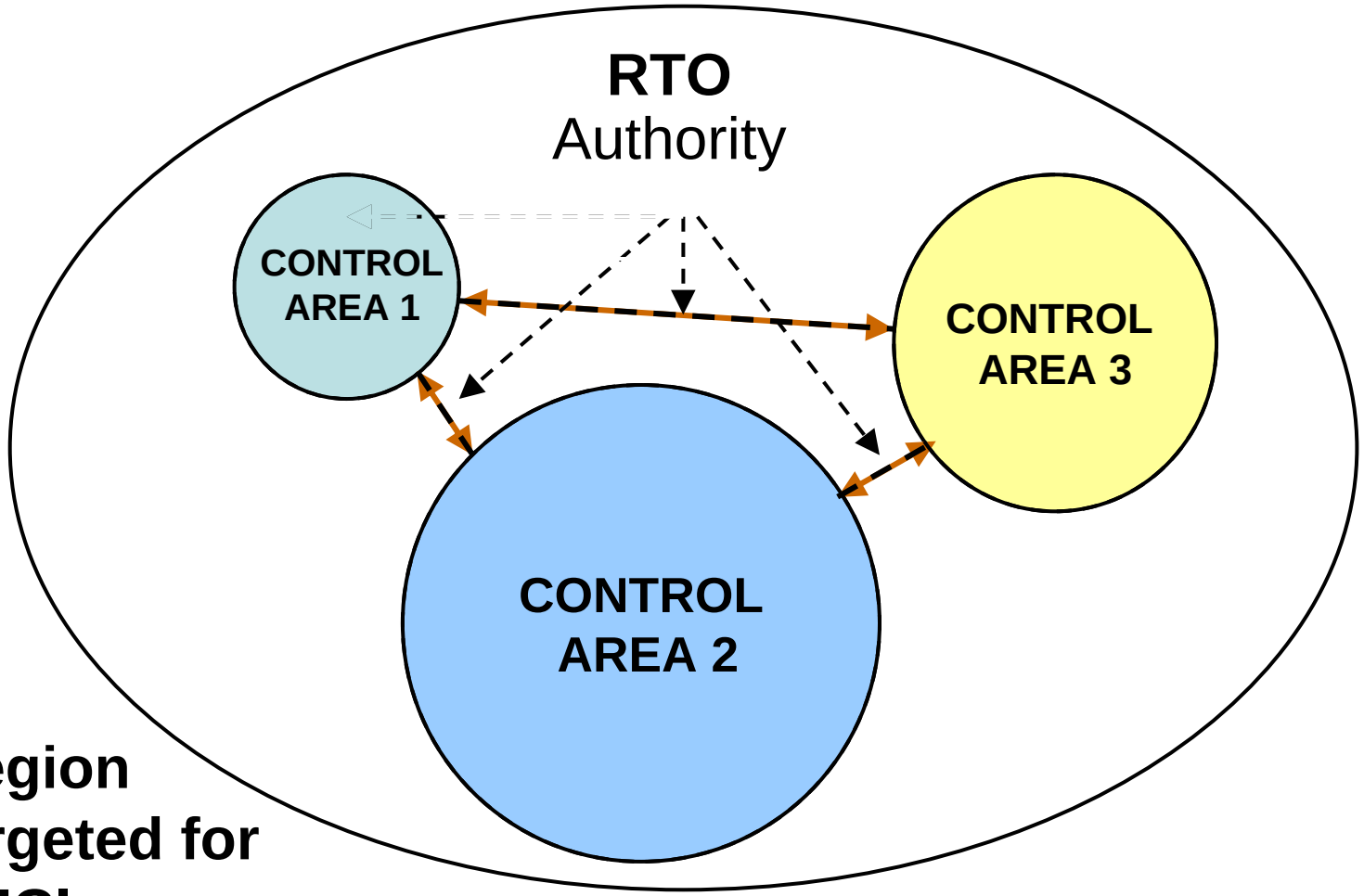
- **Covers transmission over a larger area** (compared to a traditional TSO)
  - The geographical area covered by an RTO is much dependent on the regional context (as well as the underlying entities)
- **Includes all transmission facilities under its control**
  - Could imply being the security coordinator for a number of **distinct control areas** within the region

# RTO Major Responsibility

**Must have the <u>exclusive authority</u> for maintaining short-term power system reliability over the whole region**

- Receiving, confirming and implementing all interchanges scheduled between control areas
- Ordering generation redispatch if needed for reliable operation
- Approving scheduled transmission outages

# RTO and Control Areas




**Region targeted for RECI**

# RTO Market Operation

- **Scheduling and dispatching generation**

To meet demand based on the economic merit order of the generators' offers

- Generators' offers include **physical bilateral contracts** and spot market bids
- Generators' offers include energy and/or reserves (part of the ancillary services)

# Settlements and Billing

- Collection of transmission service charges
- Disbursements of these revenues to the transmission asset owners
- Billing and collection associated to the spot market energy transactions
  - Payment to a selling market participant
    - The energy spot market price for the net difference between
      - Actual metered injections and
      - Total bilateral contract quantities sold
  - Vice-versa for a buying participant
- For bilateral contracts, the supplier bills and collects directly from the customer

# RTO Market Operation

- **Relieving congestion** by adjusting the merit order dispatch based on offer prices (a market-oriented approach)
  - Lower cost units are backed off and higher cost units are constrained on to meet demand
- **Suspending market operation**
  - Should not be initiated based solely on the evolution of the market price or the curtailment of demand (emergency situations only)

# Relieving Congestion