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Overview of the Reference Guide:
Services and Use Cases, Transactive Networks and Nodes, and Information Model

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Purpose of the Reference Guide

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The purpose of the Reference Guide is to describe the nature and characteristics of a transaction-based energy ecosystem.

- Illustrate what we mean by a transaction-based energy network
- Define a *common basis* for buildings, systems, & devices to interact with each other, the electric power grid, and 3rd-party providers of energy & various consumer services
- Explain why are transactions central to this?
  - Provide incentives that motivate behavior, provide ROI for bldg. comms. & controls
  - Make tradeoffs of energy costs, comfort, & QoS* systematic, and co-optimize them
  - Spur innovation in products & services, realize untapped energy efficiency opportunities
  - Coordinate networks of assets that cross enterprise boundaries to achieve “control”
  - Support plug-and-play integration of new assets & devices into bldg. and grid systems

* Quality of Service

Download the Reference Guide at: http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-23302_draft.pdf

Strategy: Support End-User & Grid-Related Services by Making Buildings Smarter

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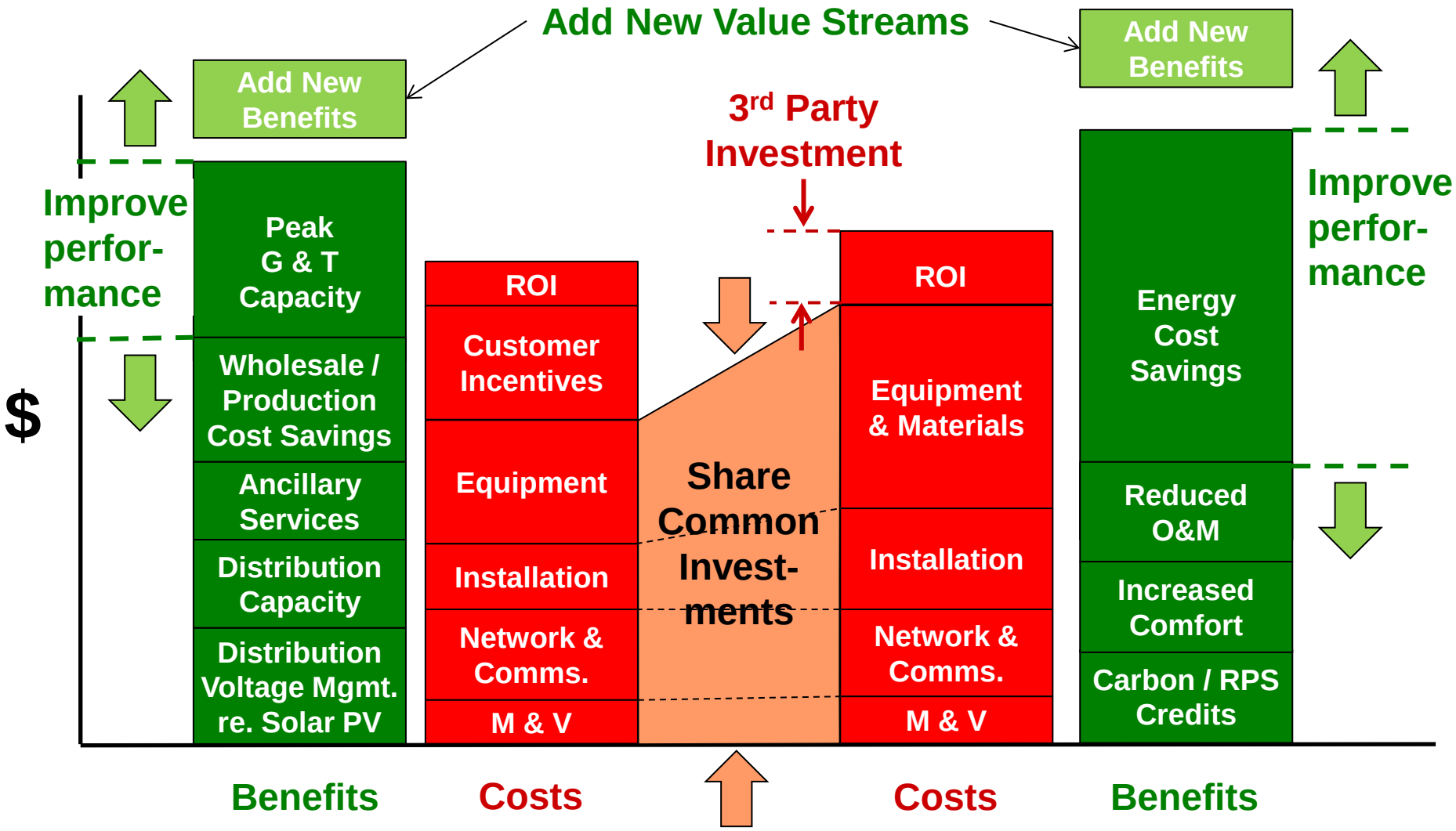

What's in the Reference Guide?

The Reference Guide describes the key functionality of a transaction-based energy network for buildings. To do this it:

- Defines the types of exchangeable products, rights, & services involved
- Categorizes types of transactions based on who is driving the exchange
- Provides a set of use cases that illustrate the range of transactions such networks must support
- Describes several prototypical transactive networks:
  - within buildings
  - among buildings and among devices & 3rd-parties across buildings
  - with the power grid
- Defines functionality of a general transactional node in such networks
- Outlines a proposed information model for machine readable & executable transactions

What Do We Mean By *Transaction?*

Transactional Energy Ecosystem: Construct integrating concepts of transactional energy & transactional control with a settlement (market) platform.

- **Transaction**: *Negotiated exchange of products, services & rights* within structured or unstructured markets that enables allocation of value among all parties involved (e.g., settlement).
- **Transaction-based energy:** Combination of *information, data & energy infrastructure to enable energy-based transactions.*
- **Transaction-based energy services:** *Services* that generate pareto-optimal outcomes *for energy providers & customers* that *balance all parties' energy needs against available resources*.
- **Transaction-based control:** *Means of executing transactions to accomplish automatic control* of building equipment & other energy systems in response to data and value streams.

Exchangeable Products, Services & Rights

A transaction may involve delivery of:

- a *physical product*, such as energy or electric power
- a *physical service*, such as a building retrofit or operations & maintenance
- *information*, such as diagnostics, advice, a control strategy, a software application

- a *right,* such as a limit on the use of a share of capacity, or throughput on a delivery system (e.g., a bldg. system, the grid)
- a *financial product*, such as a futures contract (advance purchase of energy)

- **Are there other important types of exchangeable products, services, and rights?**

Four Categories of Transactions

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Distinguished by primary motivation (value derived) for the transaction

1. **End-User Services** – purchased by end users to balance and co-optimize their overall energy costs, comfort & convenience

2. **Energy Market Services** – the power grid offers to customers that reflect everyday costs of production & delivery

3. **Grid Services** – purchased or incentivized by the power grid that are required for its reliable operation

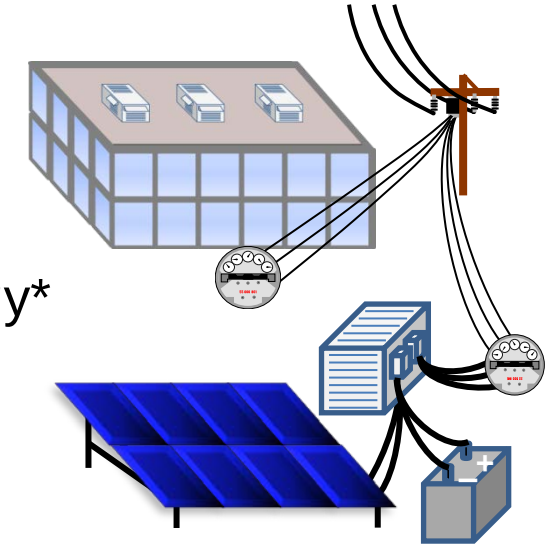
4. **Societal Services** – have a value agreed upon & acknowledged by society, monetized by a governing entity, with benefits provided to all involved or affected parties

- **Are there other important categories of transactions?**

Use Cases (1)

End-User Services

- 3rd-party energy provider
- Efficiency shared savings
- Tenant contracts with building owner for energy*
- Transactive control for large commercial building HVAC systems*
- Diagnostics & automated commissioning*
- Data centers trade jobs
- Microgrid coordination*
- Trading positions in EV charging queue



* discussed in next presentation

Societal Services

- Emergency power rationing
- Efficiency incentive payment
- Air-shed management

- **We would like to describe even more end-user services.**
- **Do you have any to offer?**

Use Cases (2)

Grid Services

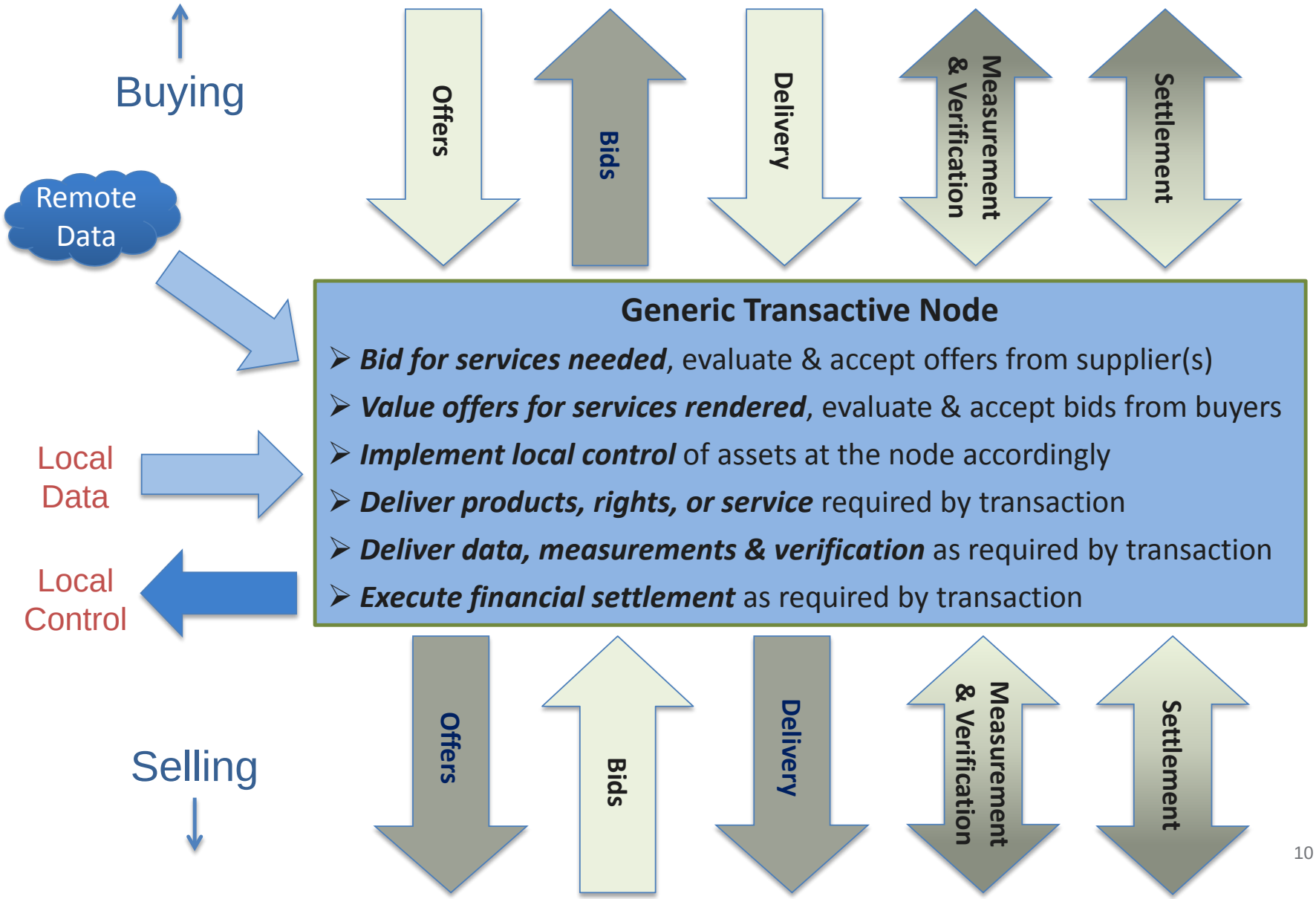
- Interruptible service or direct load control*
- Transactive retail energy market
- Trading allocated capacity rights
- Ancillary services via aggregator
- Transactive acquisition of ancillary services
- Rate dependent priority for cold load pickup

Energy Market Services

- Dynamic rate*
- Optimize EV charging for dynamic rate
- End-use differentiated dynamic rates
- Transactive energy market exchange
- Trading efficiency to relieve congestion
- Differentiated reliability service

- **Are you aware of other important use cases?**
- **Where can we find descriptions of them?**

A Generic Transactive Node



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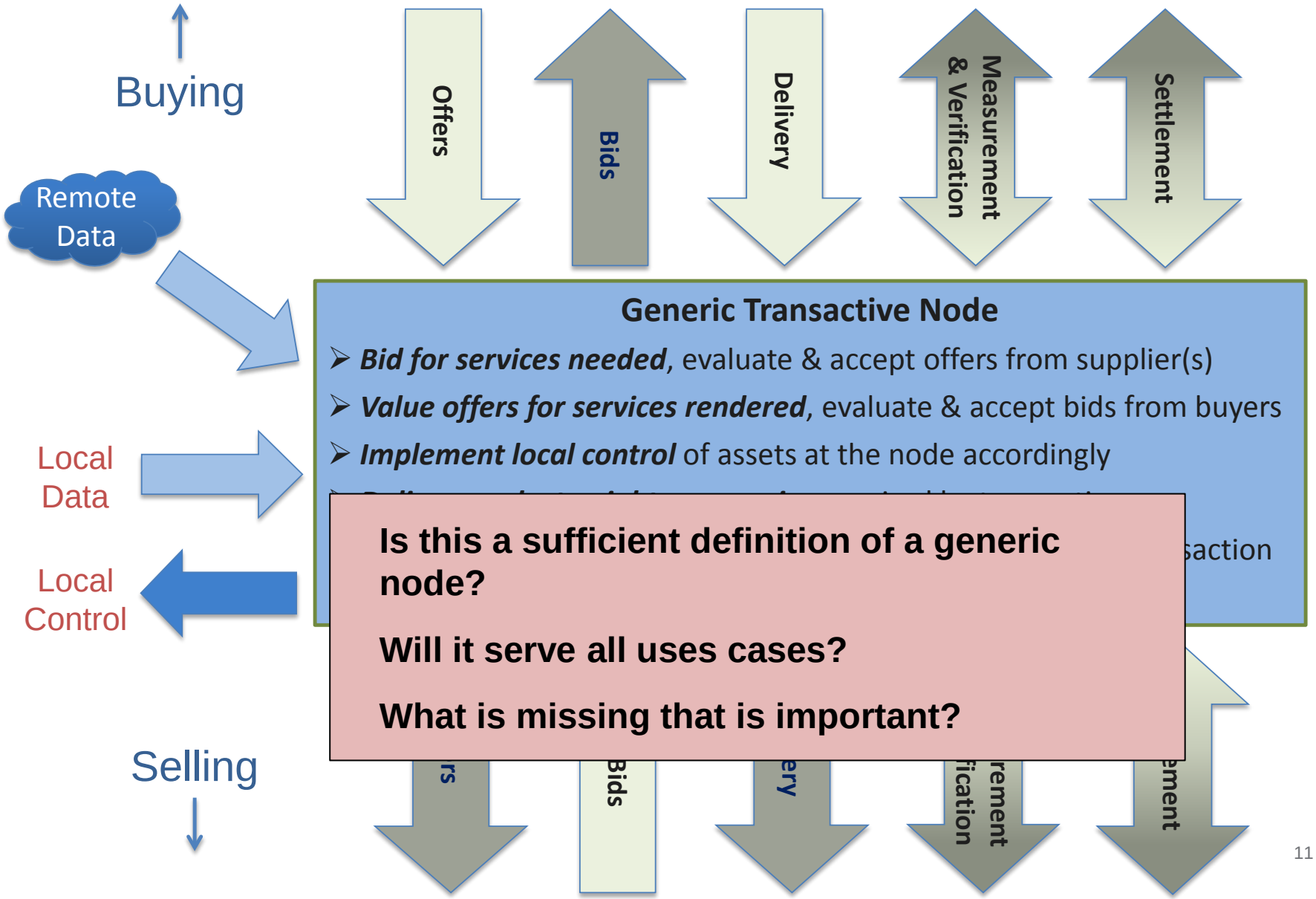


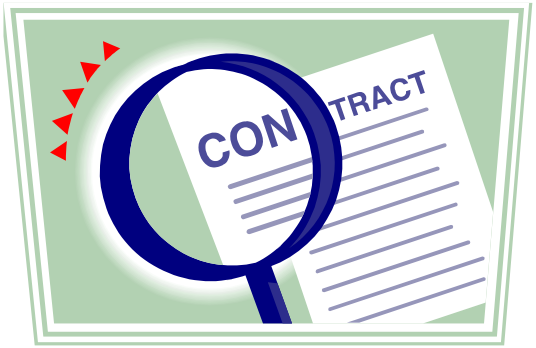
Information Model for Transactions

An information model must be developed to support machine-readable and executable transactions. Key elements describing a transaction include:

Exchangeable product, service, right, or financial product*

- Quantity & quality
- Time, place, & means of delivery
- Price, incentive, or value

* may be a time-series



Transacting parties unambiguously identified

Monitoring/regulating entity (if any)

Process for agreeing to a transaction

- Negotiation, auction, etc.

Terms and conditions

- Measurements/data required & means of verifying/validating deliverable(s)
- Financial settlements & means of payment
- Financial penalties
- Default terms & conditions
- Repudiation
- Acknowledgement

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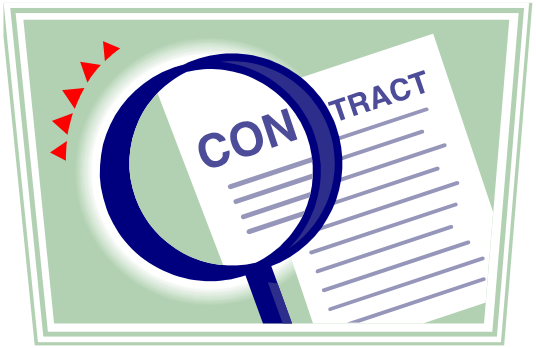

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Is this necessary?

Is it always required?

Are there other elements that are important?