

P•WERMATCHER Architecture

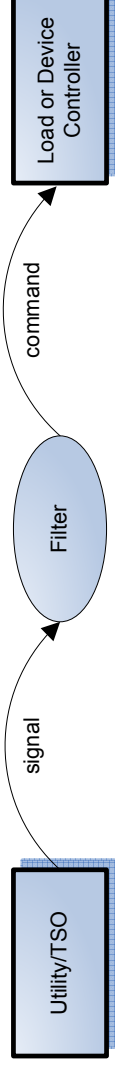
smartgrid technology



SmartHouse/SmartGrid

WP2 – Architecture Meeting

Traditional Load Shedding



Traditional Load Shedding: a signal is sent to a demand site, and results in a load control command to a device or device controller (usually shedding load)

Price-based Demand Response



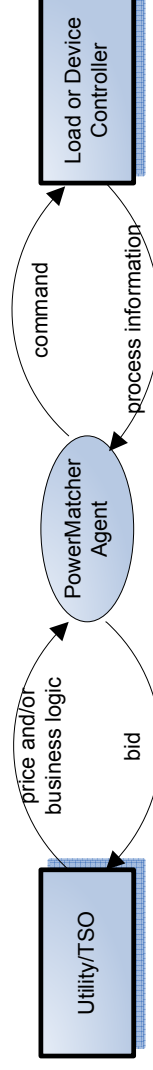
Price-based Demand Response: business logic (usually a price signal) is sent to a demand site, where, based on internal state, an intelligent process transforms the business logic into a load control command to a device or device controller

Centralized Control



Centralized Control: process information is sent to the utility/TSO; the Utility/TSO optimizes control of a cluster of devices and sends a schedule for operation or a price scheme to a demand or supply site; the schedule or price scheme, together with operational process information, is transformed into a load control command to be sent to a device or device controller

P•OWERMATCHER smartgrid technology Coordination



PowerMatcher Coordination: bids are sent by a local agent to the utility/TSO based on the state of a device; based on these bids a price signal (plus other business logic) is sent to a demand or supply site; there it is transformed by the agent into a load control command to be sent to a device or device controller

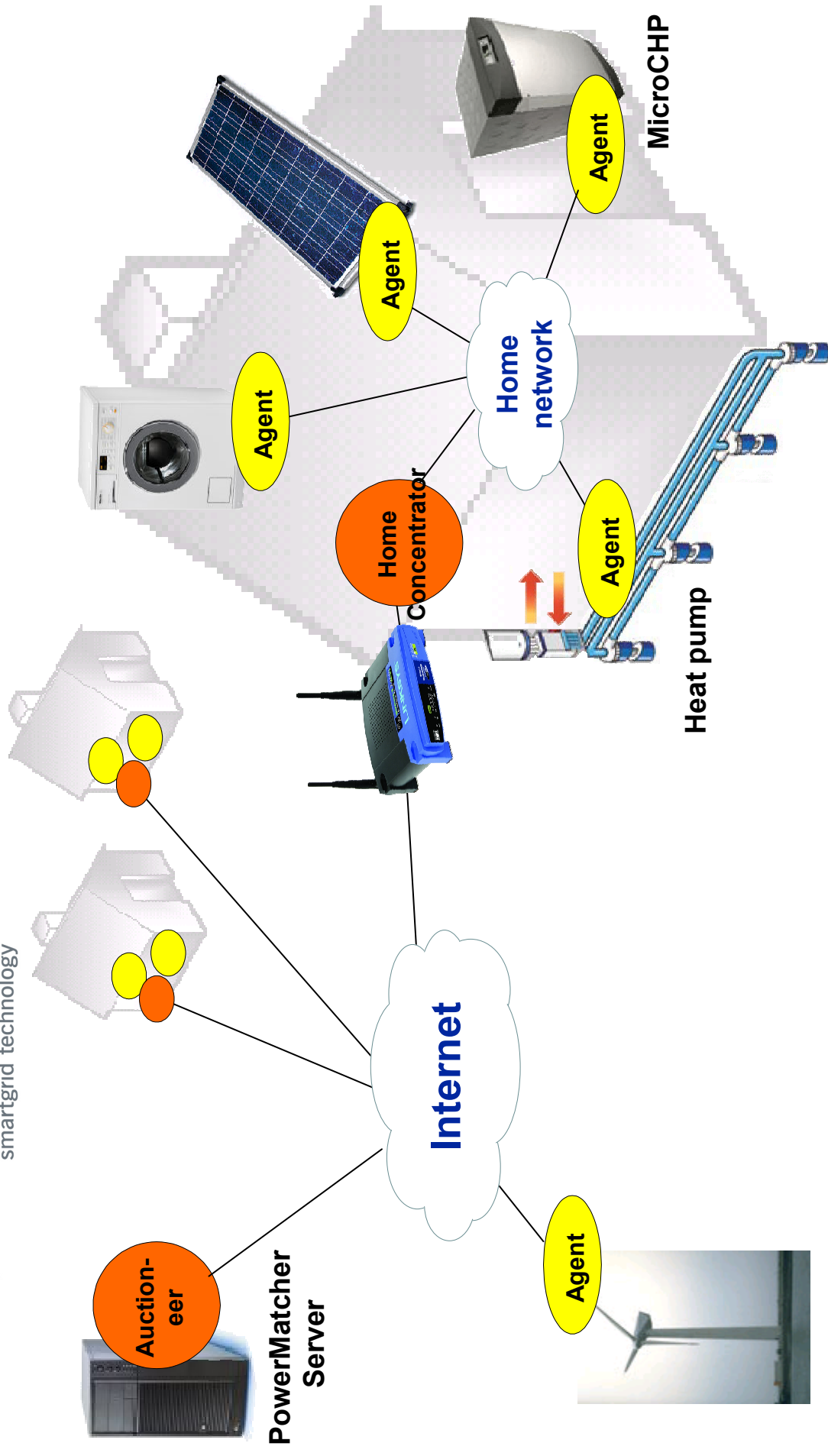


Architectural requirements

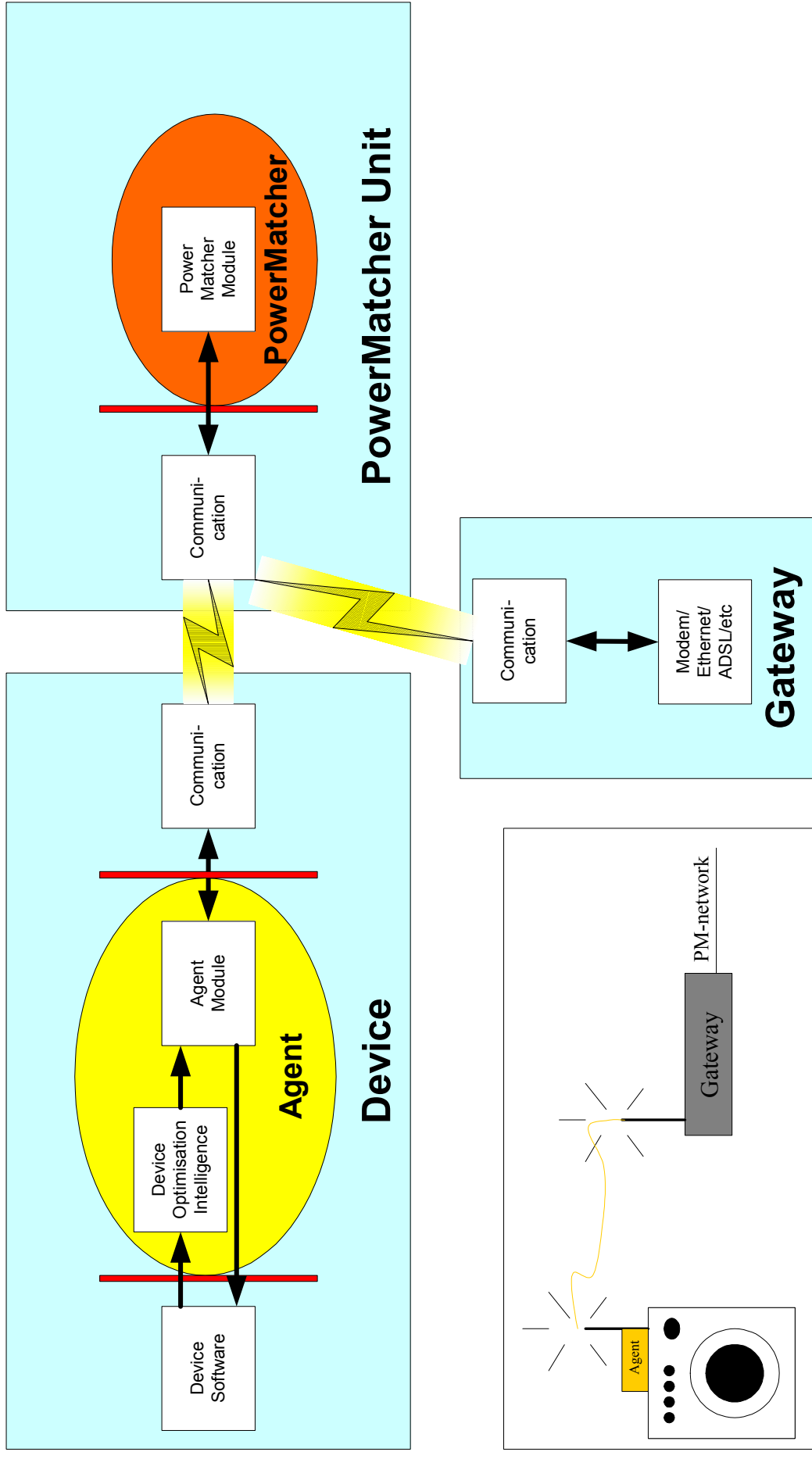
- Different infrastructures $\Rightarrow$ **flexibility**
- Difference between devices $\Rightarrow$ **flexibility**
- Different scales $\Rightarrow$ **scalability**
- Different platforms $\Rightarrow$ **portability**
- Consumer devices $\Rightarrow$ **cost, form factor**
low power, reliability



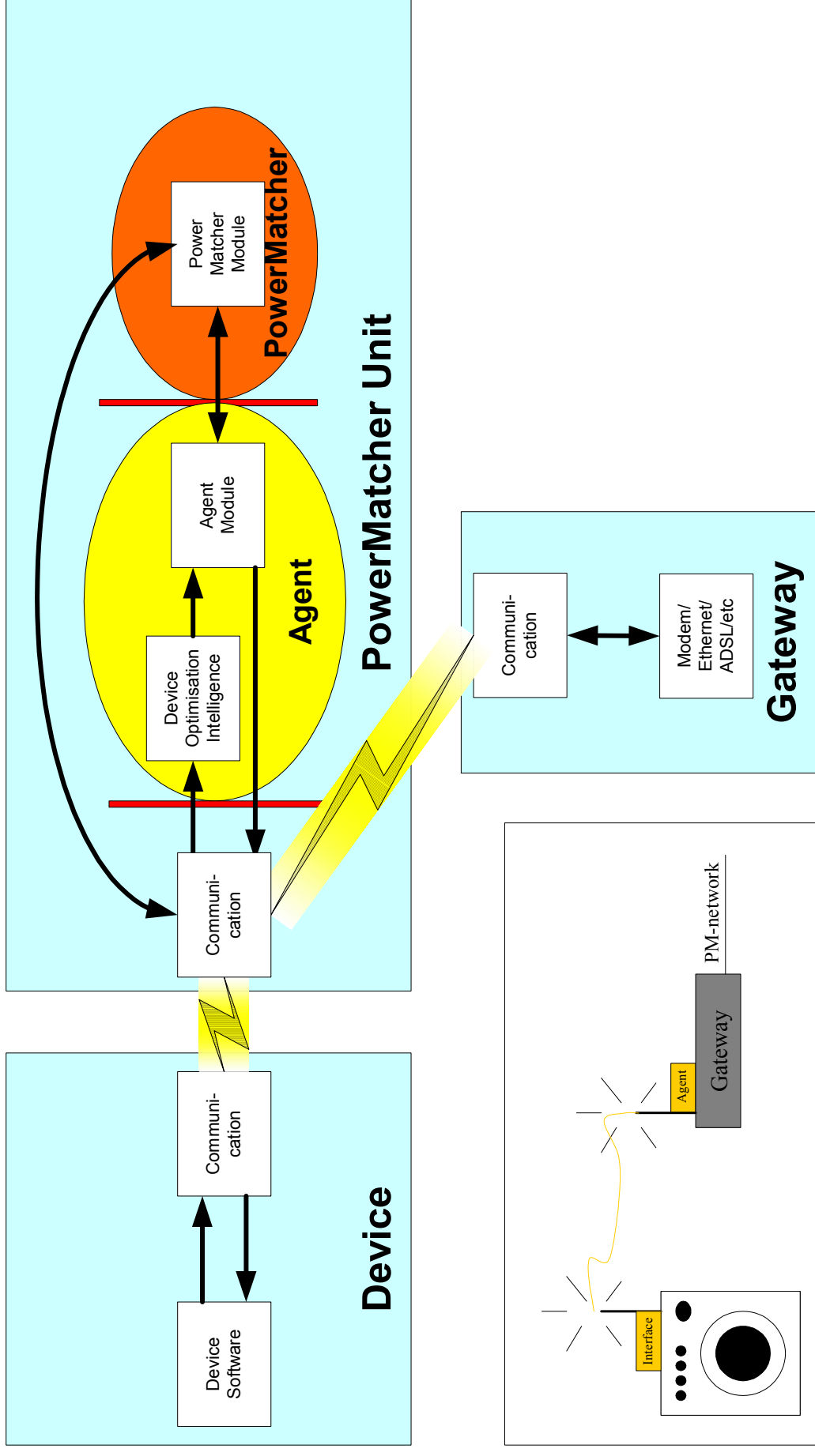
POWERMATCHER smartgrid technology Overview



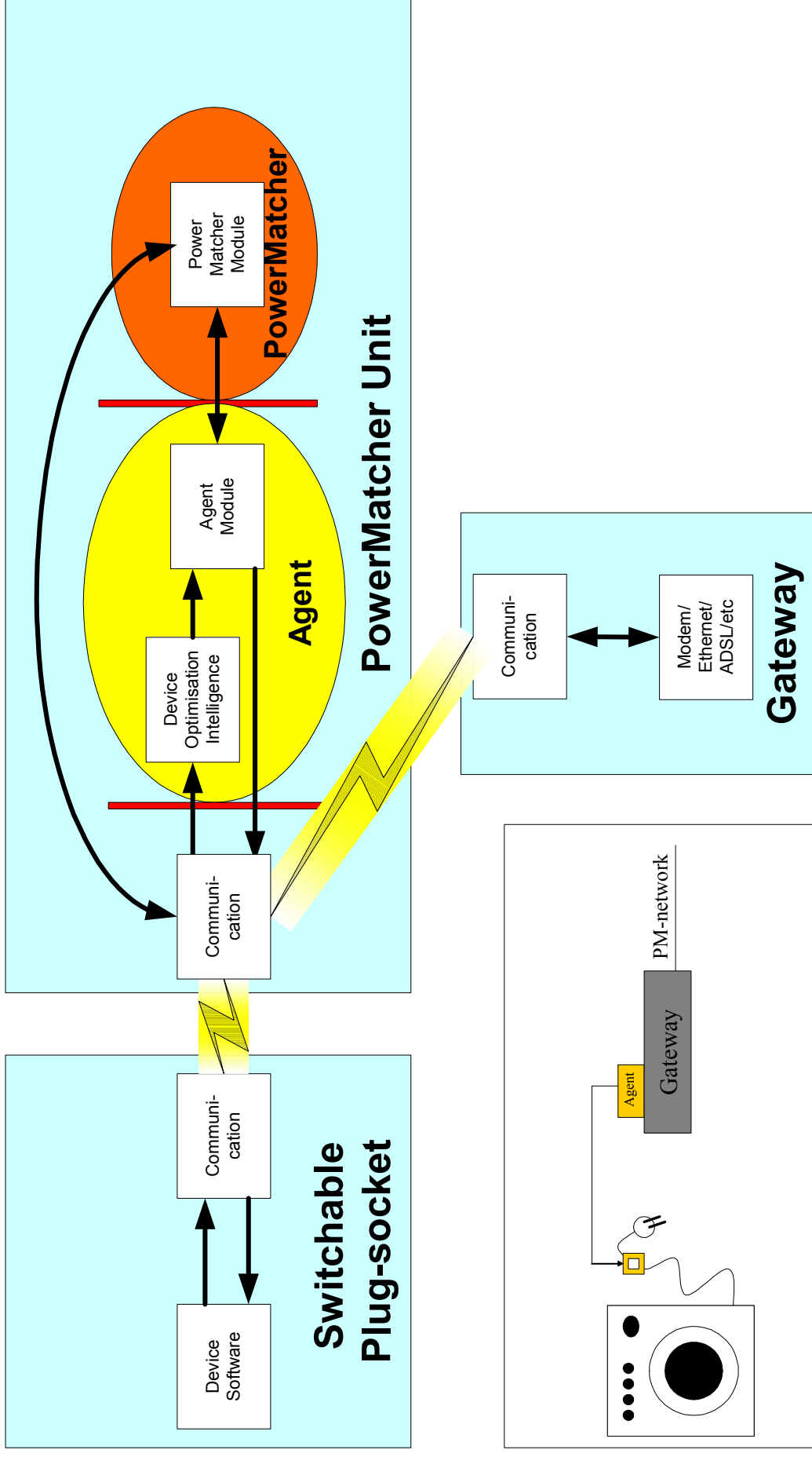
Architecture 1: Fully integrated agent



Architecture 2: limited interface agent

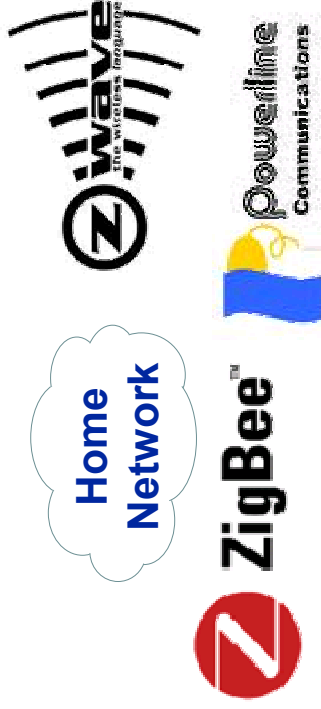


Architecture 3: no-ICT interface agent



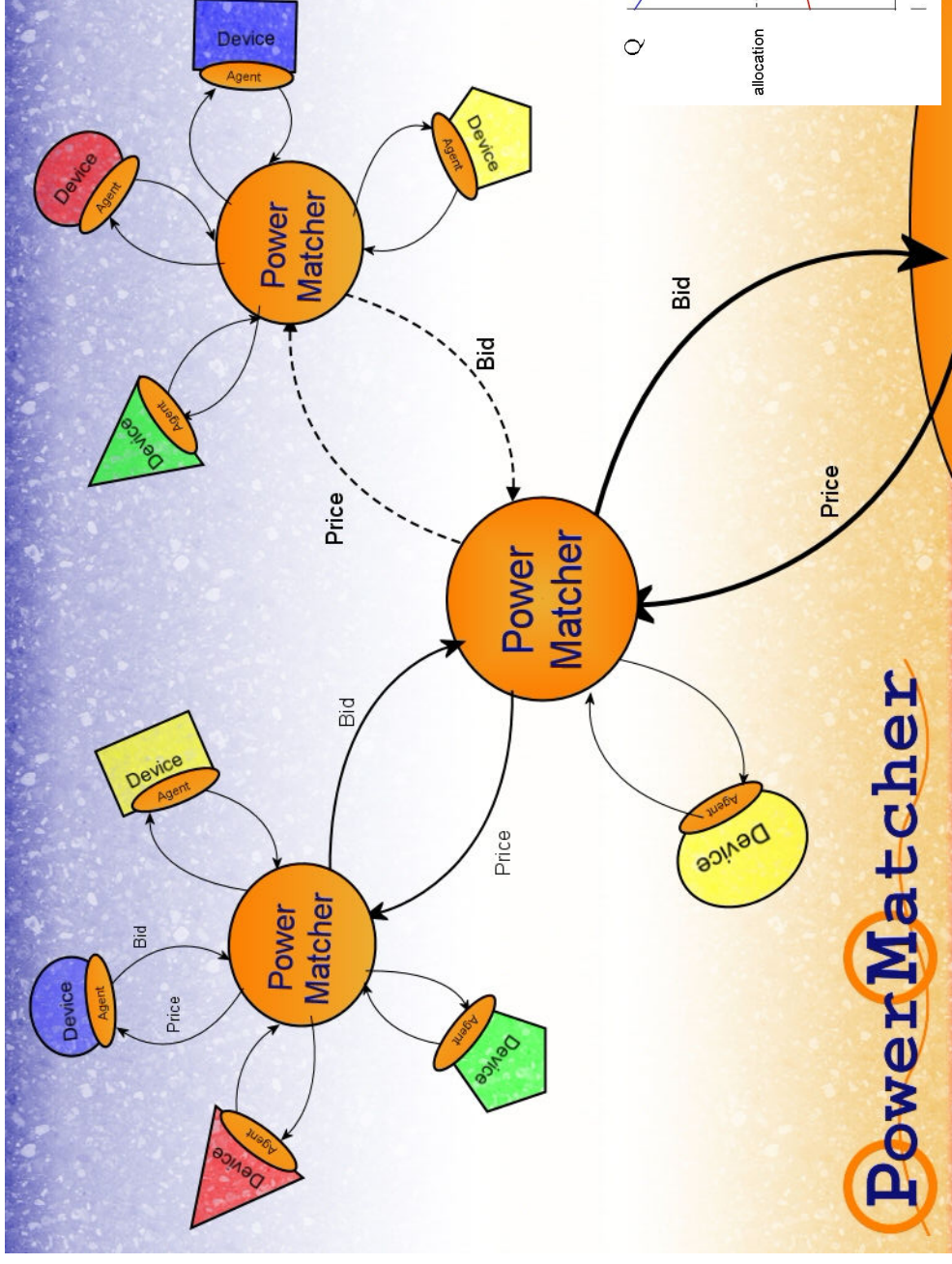
Communication independent

Device ⇔ Agent ⇔ Concentrator/Auctioneer



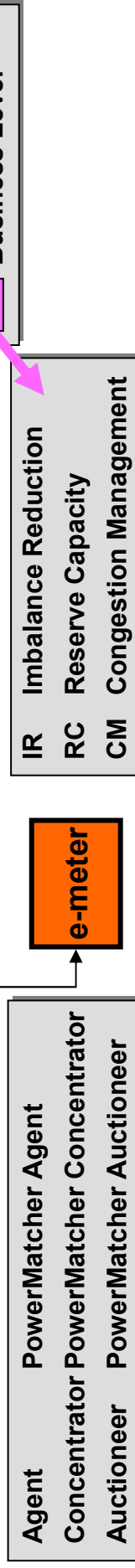
P•WERMATCHER cells - networks of networks

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Software Architecture

Smart House | Smart Grid



Interfaces **POWERMATCHER** SH/SG

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	Reference Business Cases:	POWERMATCHER BASED : IMBALANCE REDUCTION - RESERVE CAPACITY - CONGESTION MANAGEMENT			Proposed Protocol/ Technology	
	Example for Information/Interface	Partner1	Partner2			Further layer
PowerMatcher	Bid	Agent, Concentrator	Concentrator, Auctioneer		WCF/SOAP	TCP/IP
	Real-time price	Auctioneer, Concentrator	Concentrator, Agent		WCF/SOAP	TCP/IP
	Registry and Discovery	Agent, Concentrator, Auctioneer	Network Service		WCF/SOAP	TCP/IP
	Forecasts (climate, market)	External Portal / Webservice	Agent		SOAP or XML	TCP/IP
	Own energy usage	Loads, Generators	Electricity Meter		Out of project scope?	
Metering	Realtime metering data	Electricity Meter	Customer Interface Metering Services / SAP Database		See ISET overview	
	Electronic bill of customer	SAP-Database	Bill-checking application on customer interface		? DPWS ?	TCP/IP
	Sensor data	Load / Generator Controller	Agent		802.11 / RF / PLC	
Local Control	Switching commands	Agent	Load / Generator Controller		802.11 / RF / PLC	
	Substation Load	Substation Monitoring	Substation Agent			
	Virtual Power Plant Setpoint	VPP Operator	VPP Agent			TCP/IP
Business Control						



Some remarks

- Software architecture fits well with BEMl architecture
- Agents represent devices at low level nodes
- Agents represent business cases at higher level nodes
- Software protocol based on SOAP/XML, fits well with different communication media and with service oriented architecture
- Advanced metering, e.g. need for metering differentiation by devices



P•WERMATCHER Architecture

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SmartHouse/SmartGrid

WP3 – Field test A

WP 3A: Aggregation of SmartHouses & Enterprise Systems Testing

- Partners: ECN (lead) & SAP

- Focus:

Automatic Aggregated Control of end-user systems for energy efficiency combined with Testing of Information Exchange with Enterprise Systems using Data Traffic at Mass-Application Strengths.

- Main Objectives:

- Validation of Multi-Agent Systems-based Aggregation of Smart Houses for energy efficiency enhancement and electricity trade optimization utilizing real-time varying tariffs.
- Testing the information exchange of such a system with Enterprise systems (e.g. for billing) at data traffic levels of mass-application (~1,000,000 customers).

- Location:

- Cluster of Smart Houses: NL (connection with Integral Project)
- Data Aggregators (Control Information, Metering Data): NL
- Enterprise System Servers: Germany.

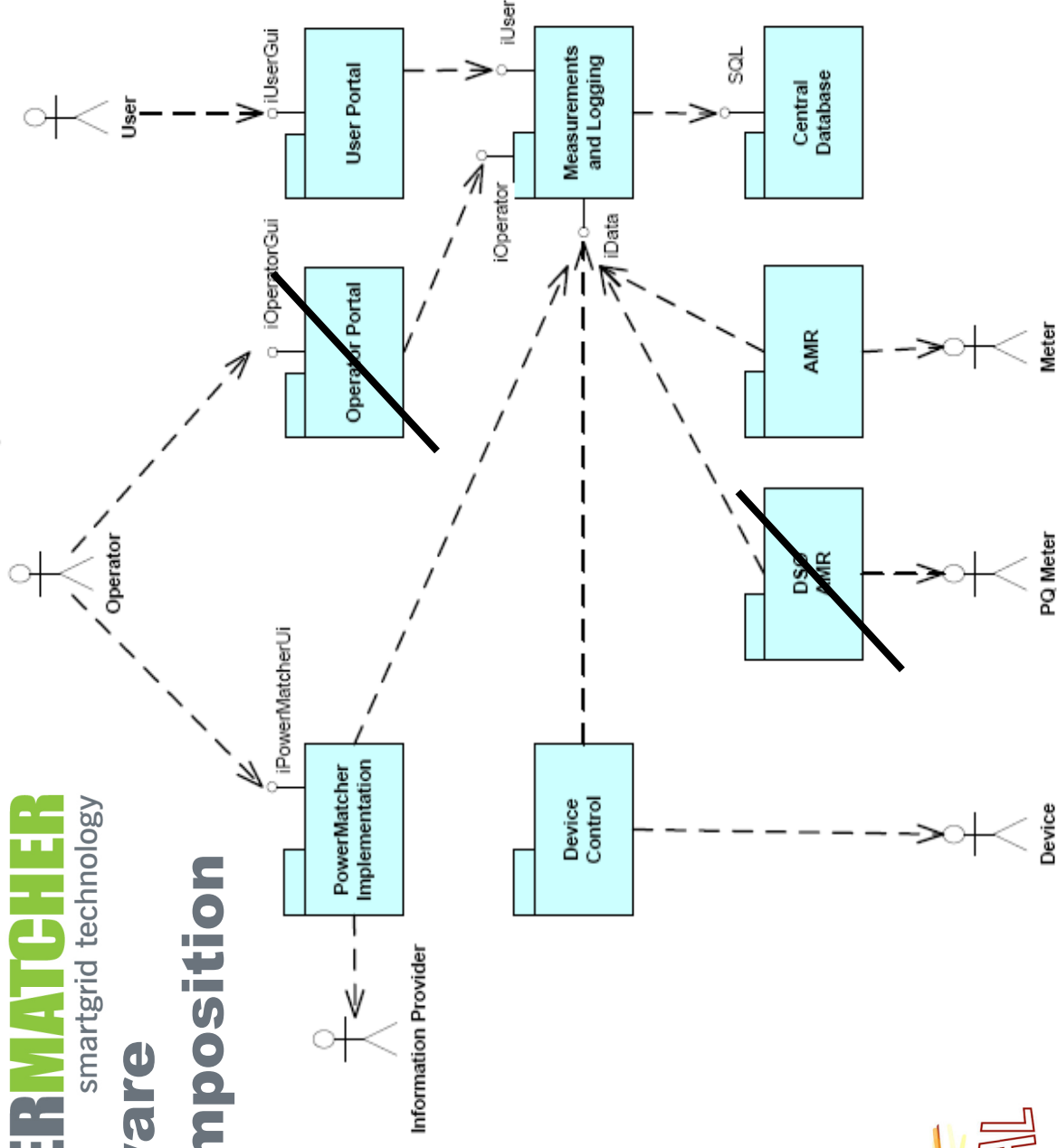


P•OWERMATCHER smartgrid technology **Version 3, current status**

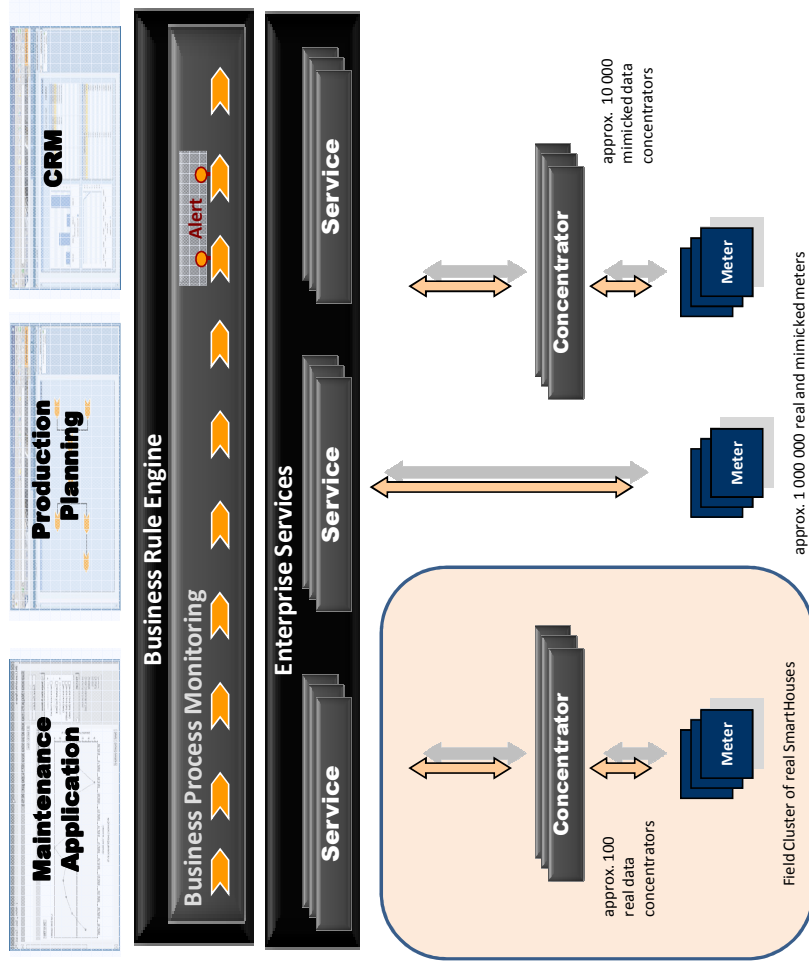
- Core Functionality (Re-)Design and Implementation
- PM Core
 - C#, .NET
 - WCF (Windows Communication Foundation)
 - Event-based interactions
- Agent Library
 - WCF/SOAP
- PowerMatcher3 implementation completed in 2008
- Simulation environment to be completed next month
- Integral field test second quarter of 2009



P•WERMATCHER smartgrid technology **Software Decomposition**

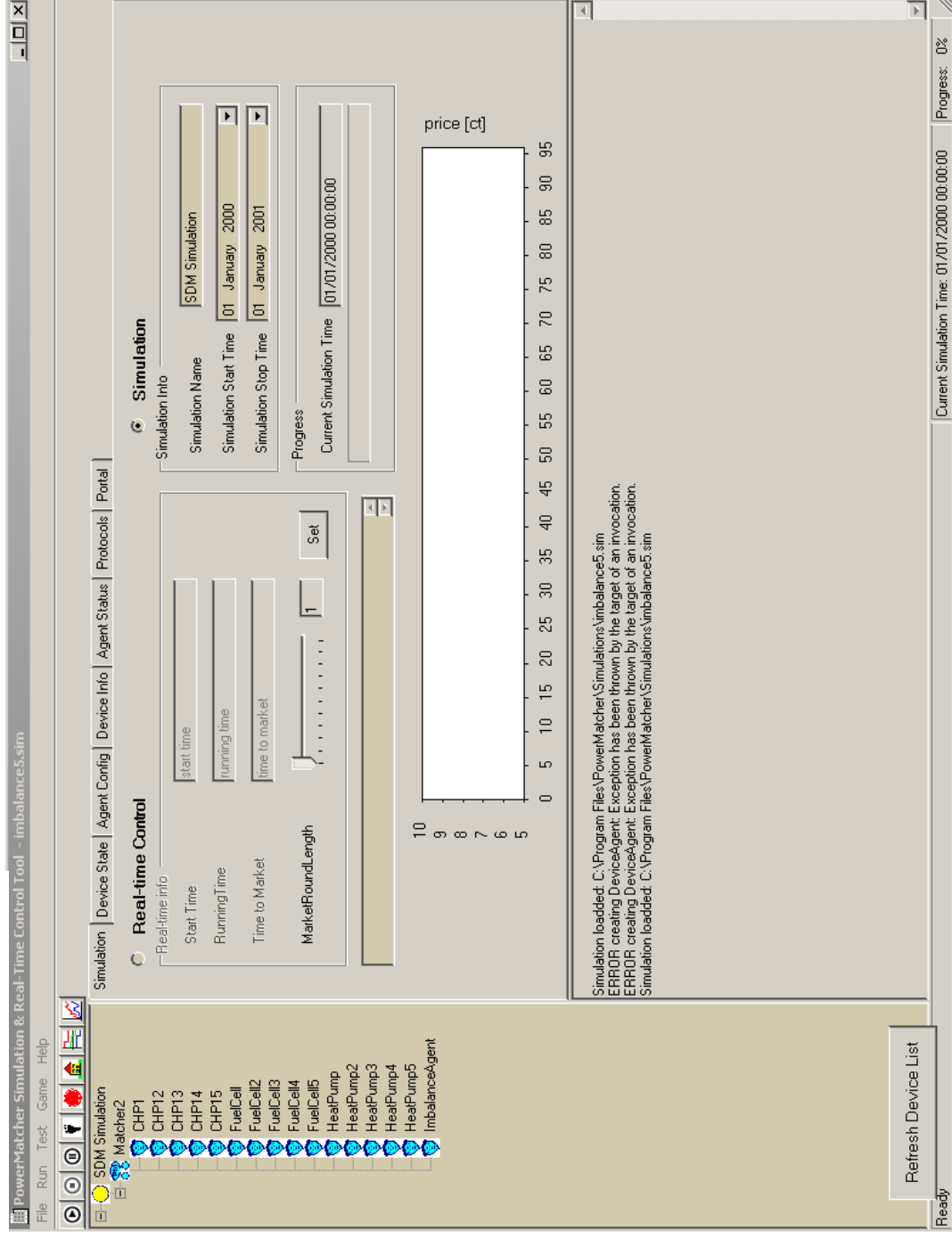


WP 3.A Setup



POWERMATCHER Simulation Tool, old

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PowerMatcher Simulation & Real-Time Control Tool - imbalance5.sim

FileRunTestGameHelp

SDM Simulation

Matcher2

CHP1

CHP12

CHP13

CHP14

CHP15

FuelCell1

FuelCell2

FuelCell3

FuelCell4

FuelCell5

HeatPump1

HeatPump2

HeatPump3

HeatPump4

HeatPump5

ImbalanceAgent

Simulation

Device State

Agent Config

Device Info

Agent Status

Protocols

Portal

Property

SDM Value

Conventional Value

RoomTemperature15.665128758542816.9

RoomTemperatureSet1616

TapWaterTemperature66.562885162034823

TapWaterSetpoint7070

OutsideTemperature3.43.4

SpaceHeatingBufferTe2020

YearlyEnergyConsumption483000000

Allocation-10000

StateTime01/01/2000 02:55:0001/01/2000 02:50:00

CHPStateSpaceHeatingOff

update state while simulating

Simulation loaded: C:\Program Files\PowerMatcher\Simulations\Imbalance5.sim

ERROR creating DeviceAgent: Exception has been thrown by the target of an invocation.

ERROR creating DeviceAgent: Exception has been thrown by the target of an invocation.

Simulation loaded: C:\Program Files\PowerMatcher\Simulations\Imbalance5.sim

Ready

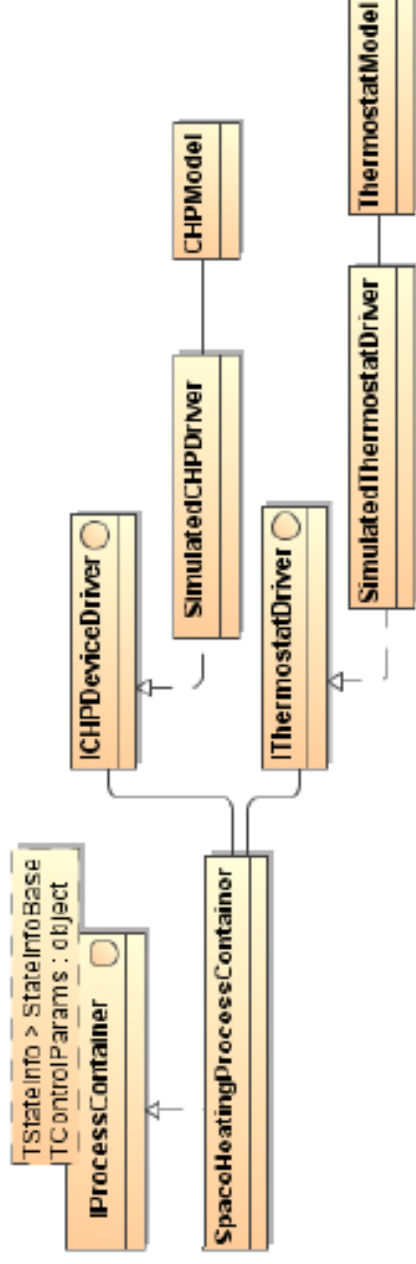
Refresh Device List

Current Simulation Time: 01/01/2000 03:00:00

Progress: 0%

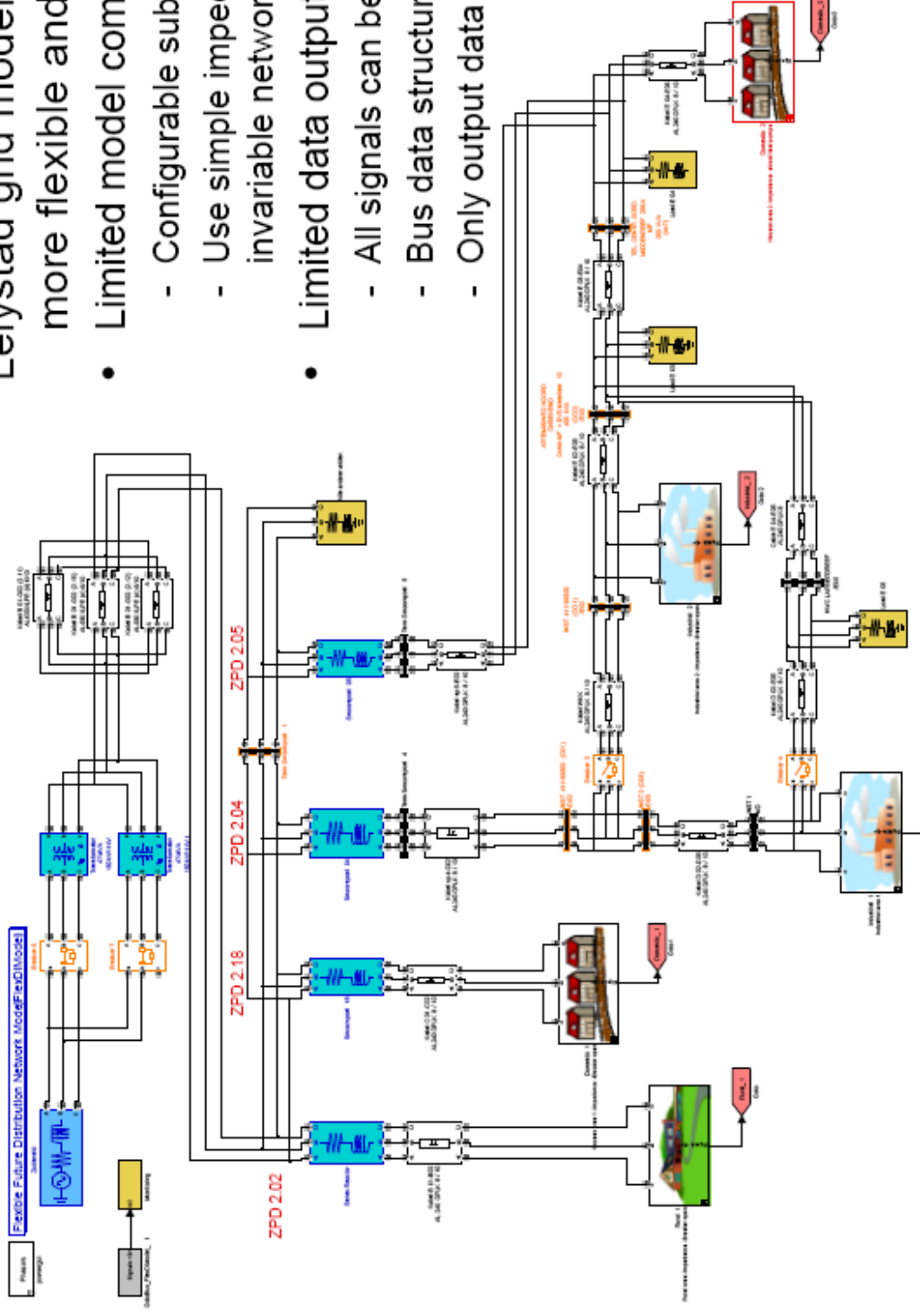
P•WERMATCHER smartgrid technology **Simulation Tool, new, 3**

- New design in PowerMatcher3
- Agents as autonomous processes

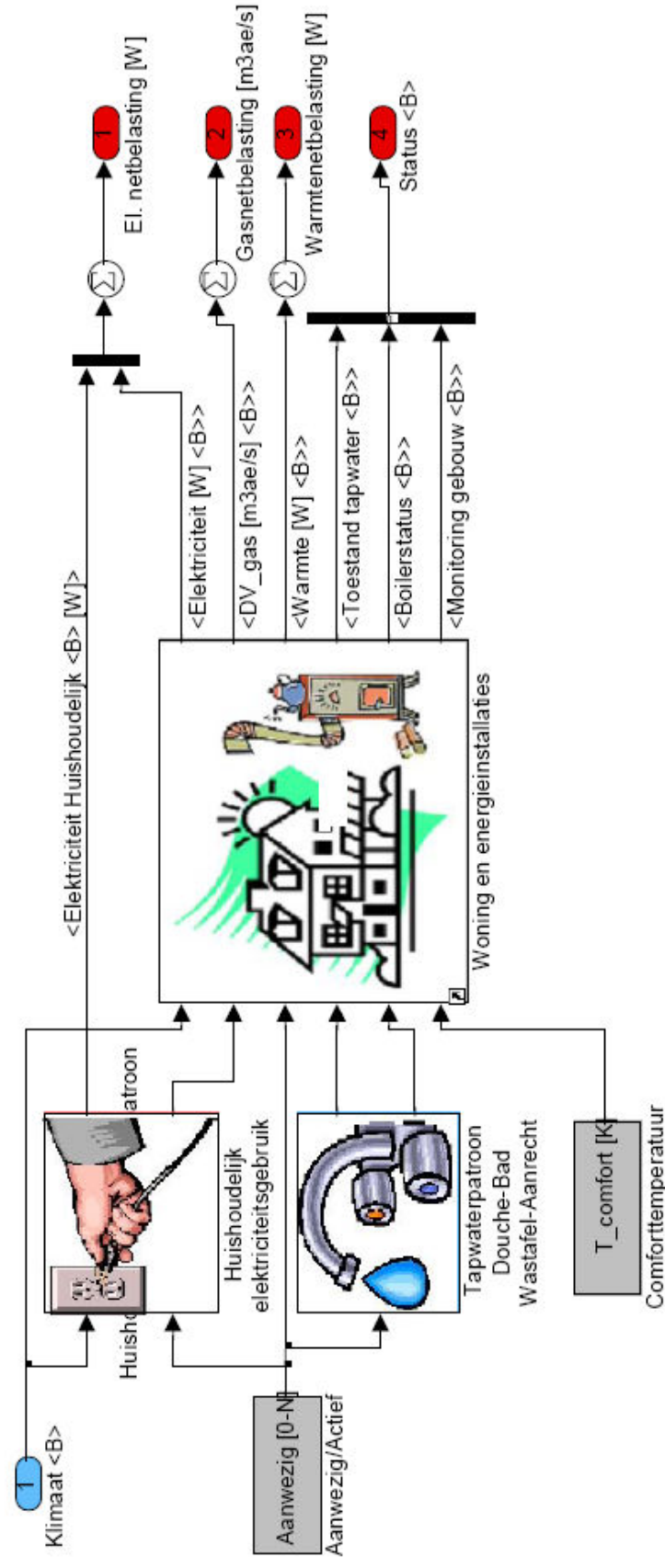


FlexDiModel Simulation - Lelystad Model

- Lelystad grid model made more flexible and efficient
- Limited model complexity
 - Configurable subsystems
 - Use simple impedances for invariable network parts
 - Limited data output
 - All signals can be addressed
 - Bus data structure
 - Only output data you need



FlexDiModel Simulation – Bee Model



FlexDiModel Simulation

- (ECN) network stability, response on slow variations:
 - wind speed variations
 - all μ CHP starting up more or less the same time (morning situation)
 - all PV varies strong more or less the same time (moving clouds)
 - load variations
 - heat variations (μ CHP).

As these events all depend on the local climate, they should depend on the very same climatic data file in order to get the right order of events in the time domain. This already is the case with the BEE_model (ECN).

- 2. (TU/e) network stability, response on fast variations:
 - short circuit in the network (resulting in voltage and phase step)
 - switch-off of the total Wind farm during peak operation
 - huge load steps.

