

Intelligent Grid Research at BCIT

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BRITISH COLUMBIA INSTITUTE OF TECHNOLOGY
A POLYTECHNIC INSTITUTION

Agenda

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- 12. Grid/Core Topologies**



Problem Definition

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BC Hydro eyes 25% rate hike by 2011

That's just a start. The annual cost for an average homeowner may jump as much as \$500

Scott Simpson, Vancouver Sun

Published: Saturday, January 26, 2008

The average cost to heat and light a home could increase \$500 a year by 2011, driven by a projected 25-per-cent hike in electricity rates and aggressive conservation measures, according to BC Hydro documents.

A typical residential customer who heats with gas now pays about \$715 a year.

A recent Hydro report says rates must rise 25 per cent between 2009 and 2011 because of expected costs to maintain and upgrade British Columbia's aging electricity grid, as well as expenses arising from higher finance costs and "an anticipated increase in government levies."



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- PDF: Electric heating costs headed up

Problem Definition

Problems facing the Power Industry today:

- 1. Rising cost of energy**
- 2. Aging infrastructure**
- 3. Mass Electrification**
- 4. Climate Change**

Solutions pursued by Utility companies:

- 1. Optimize use of expensive assets**
- 2. Manage end-user demand**
- 3. Facilitate Co-Generation**
- 4. Use alternative/renewable sources of energy**

However, such solutions can not be implemented within the constraints of the existing old electromechanical Electricity Grid!

The Need

Existing Grid

- **Electromechanical**
- **One-Way communication**
- **Centralized Generation**
- **Hierarchical**
- **Few Sensors**
- **Blind**
- **Manual Restoration**
- **Failures & Blackouts**
- **Manual Check/Test**
- **Limited Control**
- **Few customer choices**

Required Grid

- Digital**
- Two-Way communication**
- Distributed Generation**
- Network**
- Sensors throughout**
- Self-monitoring**
- Self-Healing**
- Adaptive & Islanding**
- Remote Check/Test**
- Pervasive Control**
- Many customer choices**

Source : The Emerging Smart Grid GEF/CFSE October 2005

Drivers

- 1. Aging Infrastructure (70% of assets are over 25 yrs old)**
- 2. Reliability & Security (Blackouts, prone to attacks)**
- 3. Market Dynamics (Choice & Competition)**
- 4. Rates & Pricing (Multi-Tariffs, Time of Use, Smart Metering)**
- 5. Distributed Generation (Co-Gen, New Sources of Energy)**
- 6. Efficiency & Optimization (Demand Response, Peak Control)**
- 7. Affordable Technologies (IT, Telecom, Computing)**
- 8. Rising cost of Energy (Rising Oil Prices, Security of Supply)**
- 9. Need for Conservation (Limited Energy Sources)**
- 10. Mass Electrification (Electricity as the main driver)**
- 11. Renewable Energy (Unpredictability, Unavailability)**
- 12. Green Energy (Reduced emissions from the power sector)**

Barriers

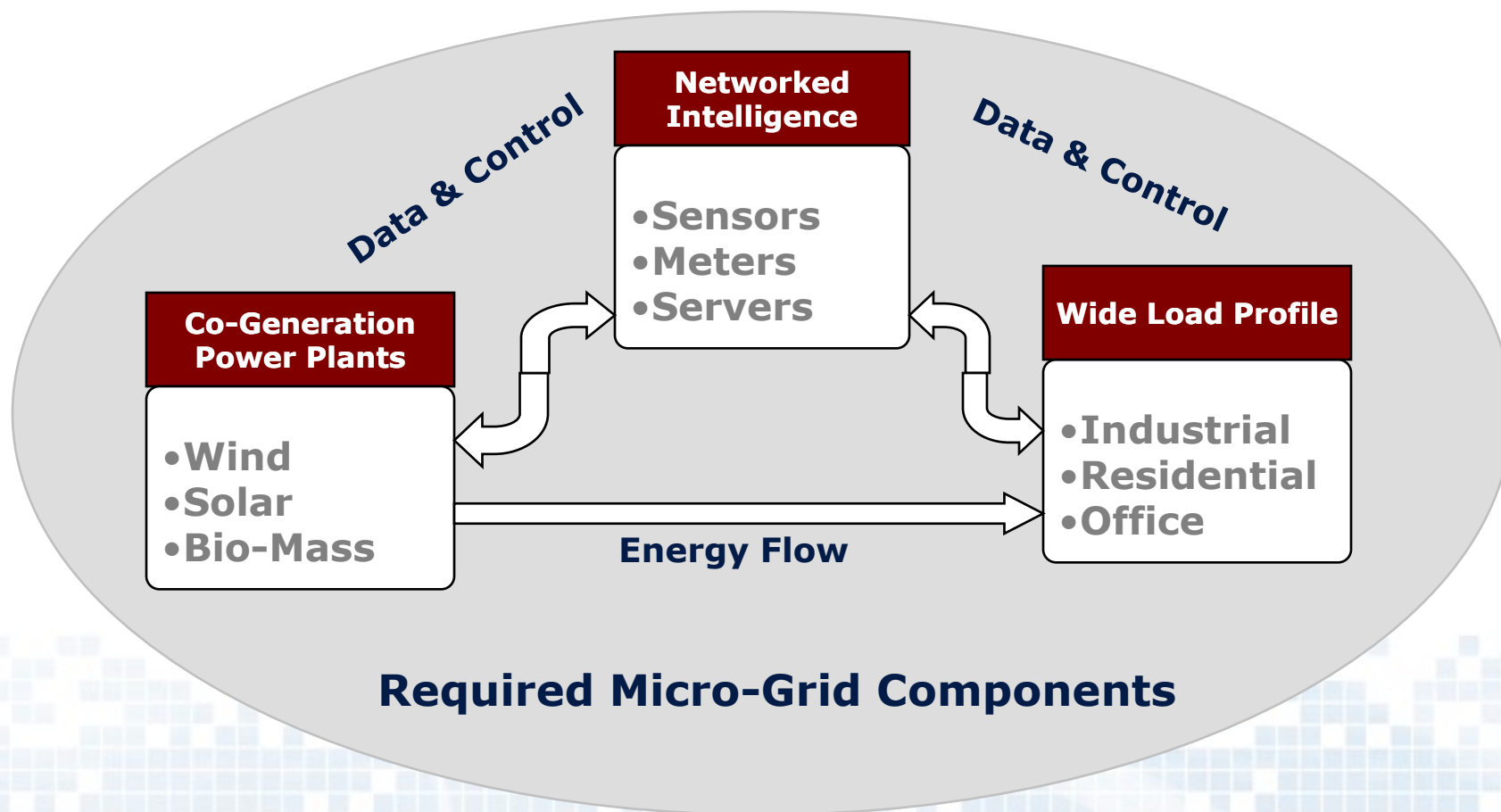
Business Barriers:

- **Regulatory & Economics**
- **Capital & Funding Constraints**
- **Absence of Industry Standards**

Technical Barriers:

- **Proprietary end-to-end solutions**
- **Absence of intelligent building blocks**

Micro-Grid Topology



BCIT's Value Proposition

BCIT's Intelligent Micro-Grid addresses the technical barriers that hampers the roll out of Intelligent Grid initiatives through:

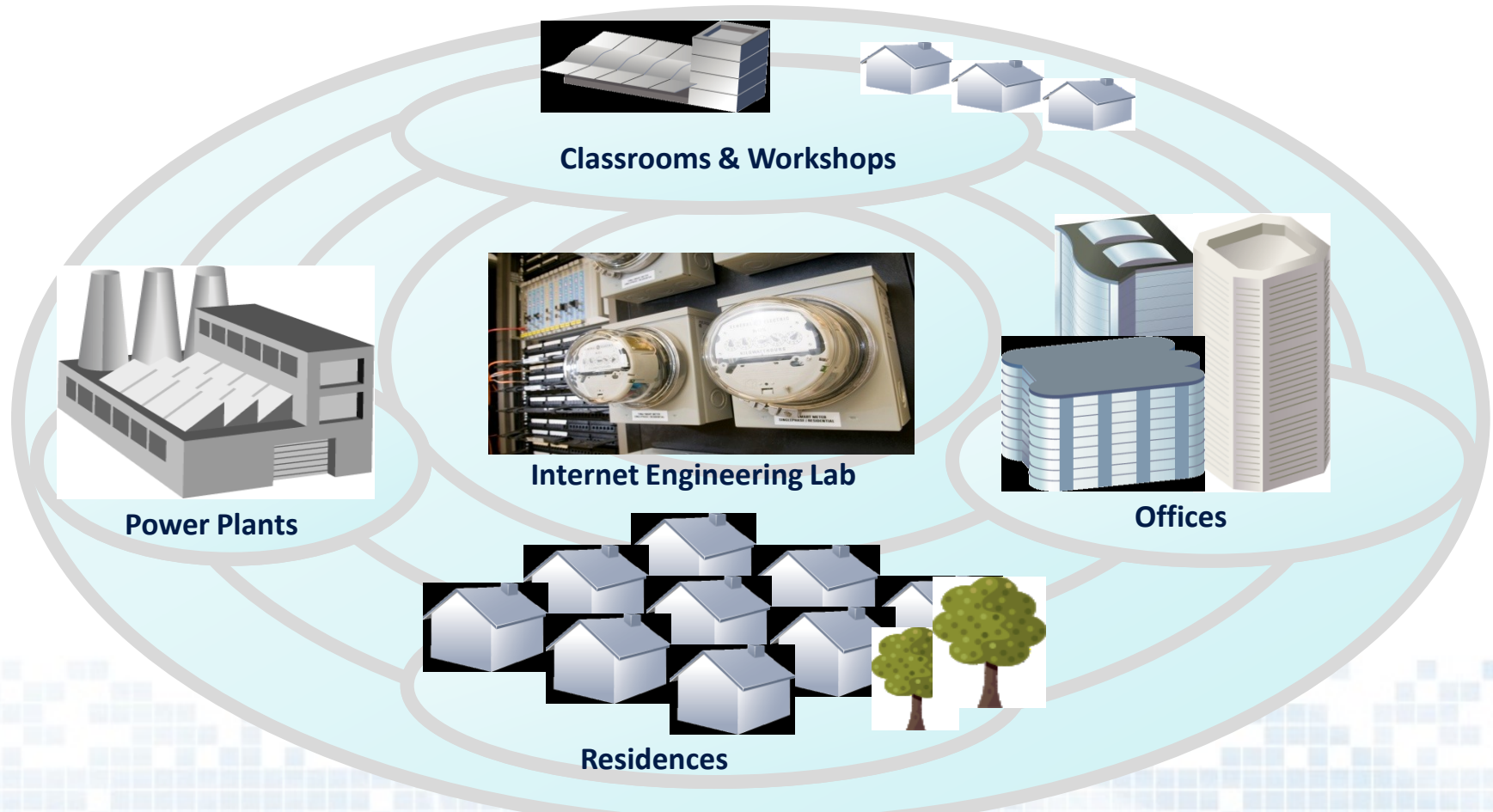
- 1. Development of Intelligent Agents as building blocks of Smart Grid under an open architecture, allowing integration of various technology components into technically viable and commercially deployable solutions for utility companies' critical services.**
- 2. Providing configurable topologies of real power systems, enabling utility companies to test and verify new services and solutions (e.g. renewable energies, clean energies, etc) in real settings and applications.**

BCIT's Intelligent Micro-Grid



BCIT's Burnaby Campus

BCIT's Intelligent Micro-Grid



BCIT's Micro-Grid Components

BCIT's Intelligent Micro-Grid



BCIT's Photovoltaic Tower

BCIT's Intelligent Micro-Grid



BCIT's Wind Power Deflector

BCIT's Intelligent Micro-Grid



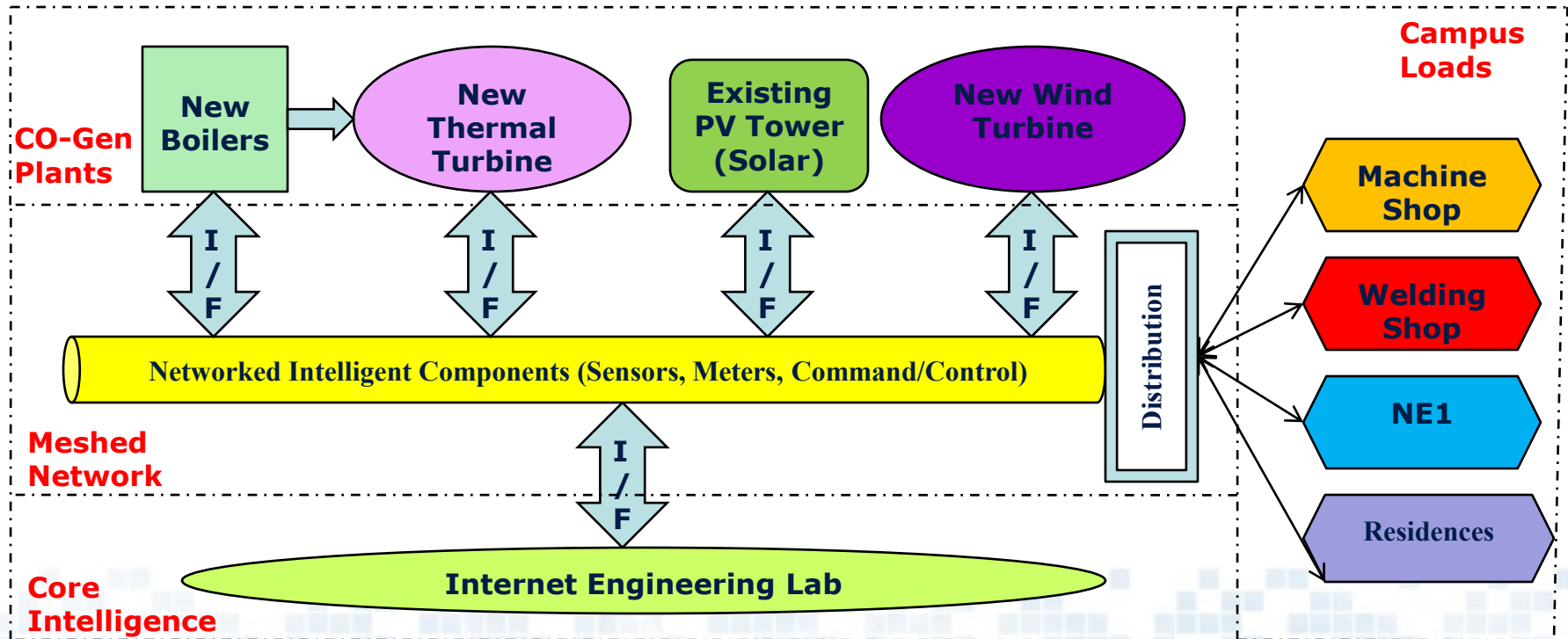
BCIT's Network Engineering Lab

BCIT's Intelligent Micro-Grid



Smart Metering Farm

BCIT's Intelligent Micro-Grid



Micro Grid Network Diagram

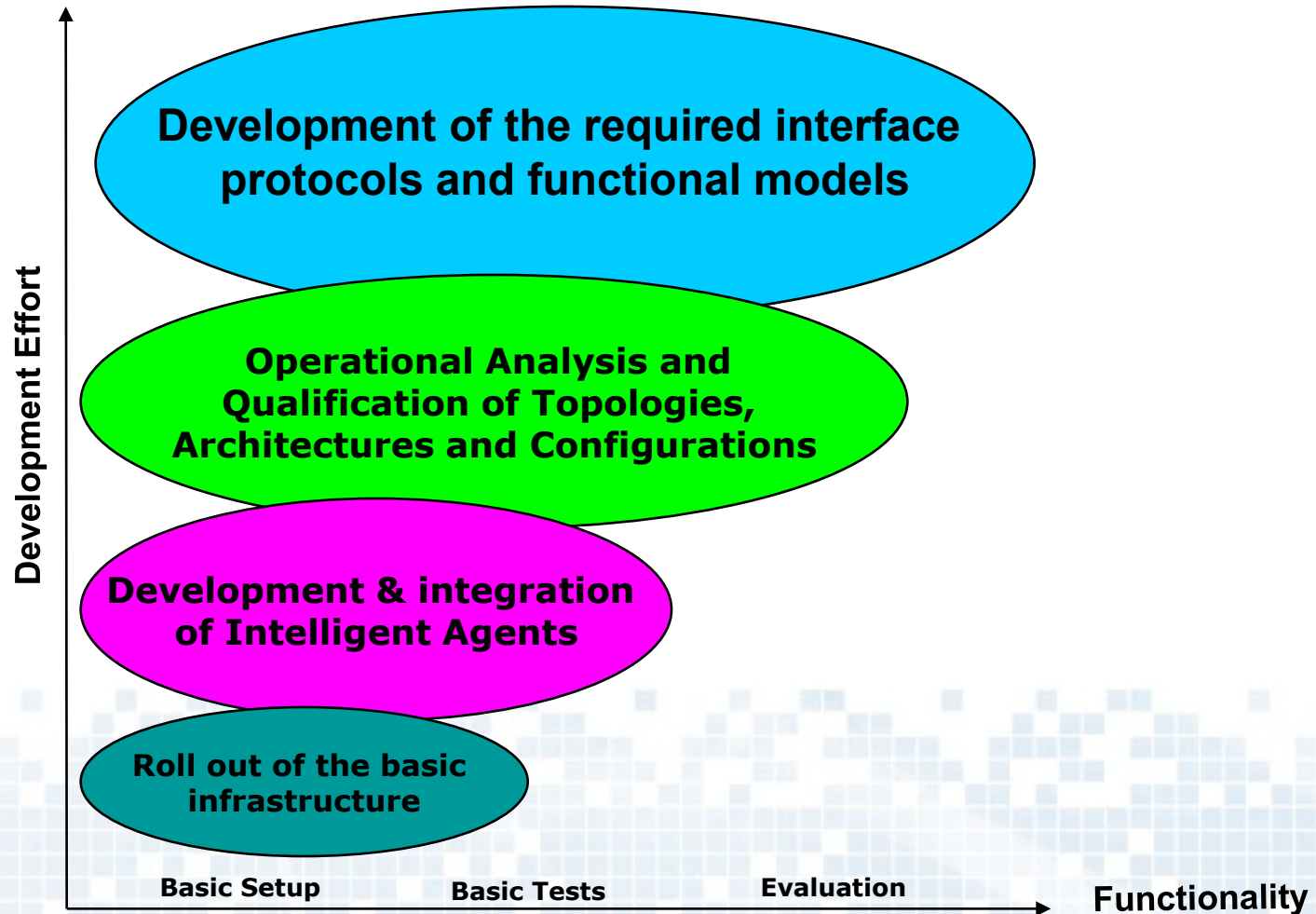
BCIT's Applied Research objectives

- **Development of Intelligent Agents for Smart Grid to enable:**
 - Provisioning Methods for Smart Termination Points (Meters, Data Aggregators, Appliances, Sensors, Controls, etc)
 - Integration Solutions for Alternative Sources of Energy (Co-Generation thru Wind, Solar, Thermal, Bio-Mass, etc)
 - Innovative Network Architecture and Topology for Smart Grid
- **Operational Analysis and Qualification of Grid's:**
 - Resilience, Reliability, Security and Scalability
 - Data Collection, Command & Control algorithms
 - Forward/backward compatibility with up & coming technologies
- **Development of Interface Protocols & Models to ensure:**
 - Interface with Utility Back-office tools (Billing, Load Management, Service Provisioning, Outage Restoration, etc)
 - Seamless end-to-end deployment, operation & maintenance
 - Easy & Intuitive human interface for operators & customers

BCIT's Intelligent Agents

- IA for visualization and integrity of time-sensitive data collected from across the termination points
- IA for event forecasting & real-time responses
- IA for distributed control to prevent cascading failures or for the graceful degradation of user service based on priorities
- IA for Real-time wide-area control to manage power generation and prevent over-provisioning
- IA for context-dependent control of components to achieve robustness, fault-tolerance, or graceful performance degradation
- IA for end-to-end integration of front-end and back-end tools
- IA for integration and carbon-footprint control of alternative energy generation systems and co-generation

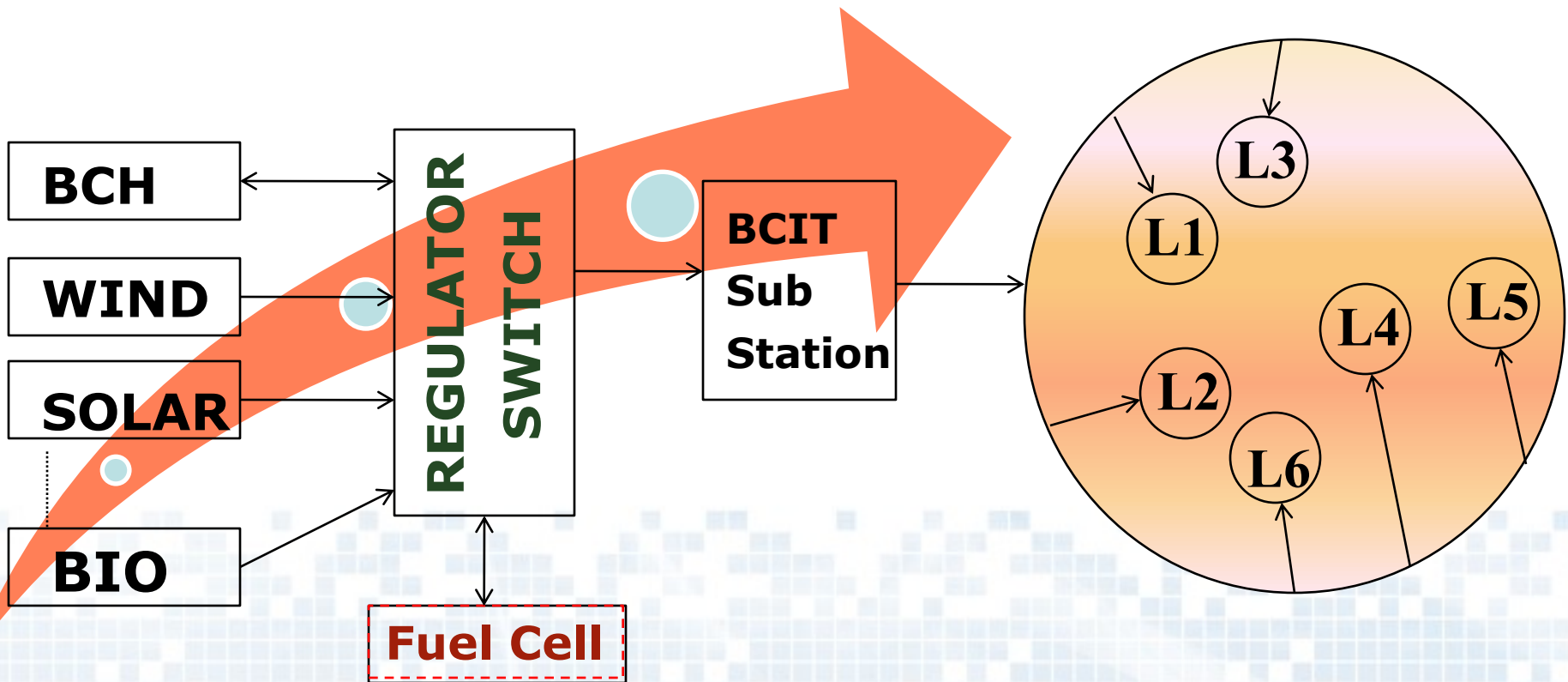
BCIT's RD&D Plan



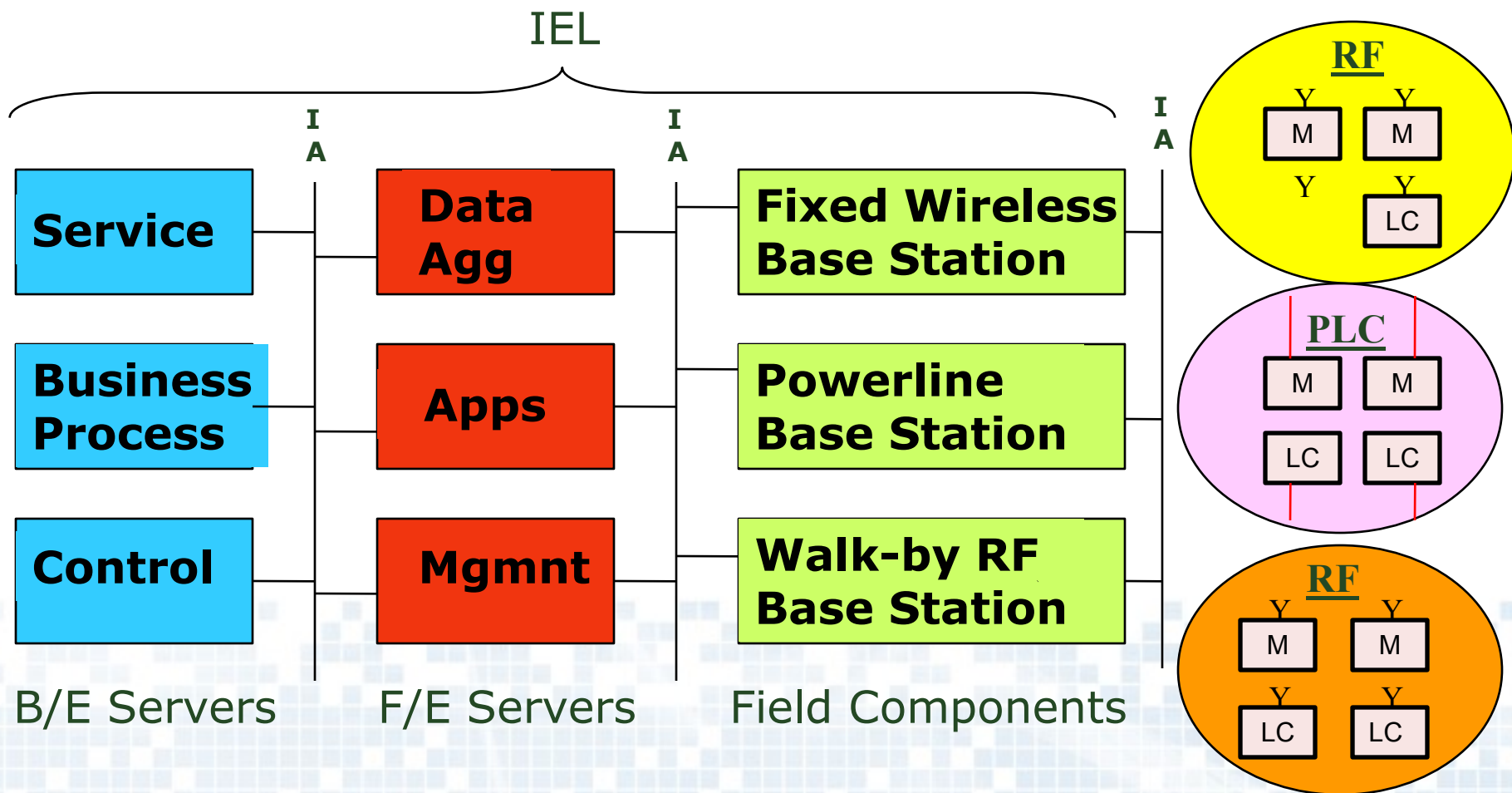
Overview of BCIT's Intelligent Agents

Biz Objective <-> Biz Process	Intelligent Agents	Org Chart <-> Workflow	Intelligent Agents	Tasks <-> Tools / Tech
Back-Office		Front-End		Field
<ul style="list-style-type: none"> ➤ Service Quality <ul style="list-style-type: none"> ❖ Outage/ Maintenance ➤ Energy Trading <ul style="list-style-type: none"> ❖ Production ❖ Energy Exchange ❖ Billing/ Accounting ➤ Cost Control <ul style="list-style-type: none"> ❖ Energy Saving ❖ Loss Control ❖ Infrastructure Upkeep ❖ Load Management ❖ Customer Information Systems & Portals 	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; color: red;">Status Alarms</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; color: red;">Cons. Data</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; color: red;">Sensor Readings</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; color: red;">Tariffs</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; color: red;">Max Demand</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; color: red;">CMND/ Control</div> <div style="border: 1px solid black; padding: 5px; color: red;">Sys Info</div>	<ul style="list-style-type: none"> ➤ Data Aggregation <ul style="list-style-type: none"> ❖ Meter Access e.g. Cons. Rec, Status ➤ Sensor Telemetry <ul style="list-style-type: none"> e.g. V, I, F, P, Alarms ➤ Network Status <ul style="list-style-type: none"> e.g. Blind Nodes, Errors ➤ Programming <ul style="list-style-type: none"> ❖ Tariffs ❖ RTC ❖ MD ➤ Network Management <ul style="list-style-type: none"> ❖ Soft Connect/Discon. ❖ Production Control ❖ Node Control ❖ Messaging 	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; color: red;">Cons. Data Status Sensor, CC</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; color: red;">Cons. Data Status Sensor, CC</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; color: red;">Cons. Data Status Sensor CC</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; color: red;">Configure Program</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px; color: red;">Network Map</div> <div style="border: 1px solid black; padding: 5px; color: red;">CMND/ Control</div>	<ul style="list-style-type: none"> ➤ PLC Network Access <ul style="list-style-type: none"> ❖ 1P/ 3P, Substations ➤ Radio Network Access <ul style="list-style-type: none"> ❖ 1P/ 3P, Substation ➤ Legacy Network Access <ul style="list-style-type: none"> ❖ 1P/ 3P, Substation ➤ Calibration : T1, T2, T3 ➤ Self-Test: T1, T2, T3 ➤ Configuration: T1, T2, T3 ➤ Routing ➤ Scheduling ➤ Load Control

Grid Topology



Core Intelligence Topology



Group for Advanced Information Technology (GAIT) Intelligent Grid

Q&A

Thank You

For further information
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