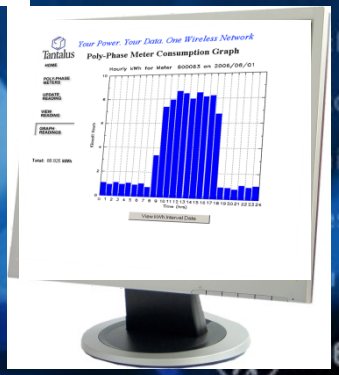
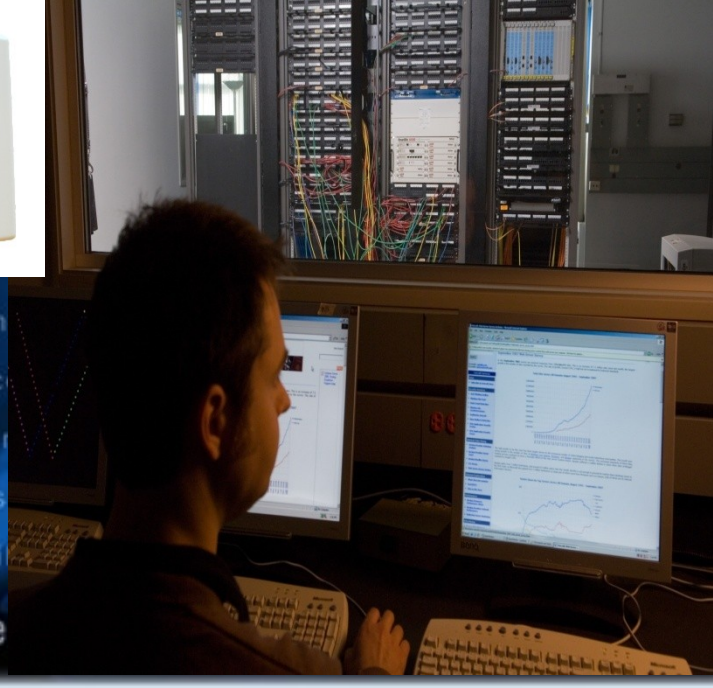




Intelligent Grid Research at BCIT

Sept 23, 2008

Dr. Hassan Farhangi (PhD, PEng, SM-IEEE) Director GAIT, TC, BCIT

Agenda

1. Problem Definition
2. The Need
3. Drivers
4. Barriers
5. Micro-Grid Topology
6. BCIT's Value Proposition
7. BCIT's Intelligent Micro-Grid
8. Applied Research Objectives
9. Applied Research topics
10. RD&D Plan
11. RD&D Focus
12. Grid/Core Topologies

Problem Definition

THE VANCOUVER SUN

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."

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	Required Grid
Electromechanical	Digital
One-Way communication	Two-Way communication
Centralized Generation	Distributed Generation
Hierarchical	Network
Few Sensors	Sensors throughout
Blind	Self-monitoring
Manual Restoration	Self-Healing
Failures & Blackouts	Adaptive & Islanding
Manual Check/Test	Remote Check/Test
Limited Control	Pervasive Control
Few customer choices	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

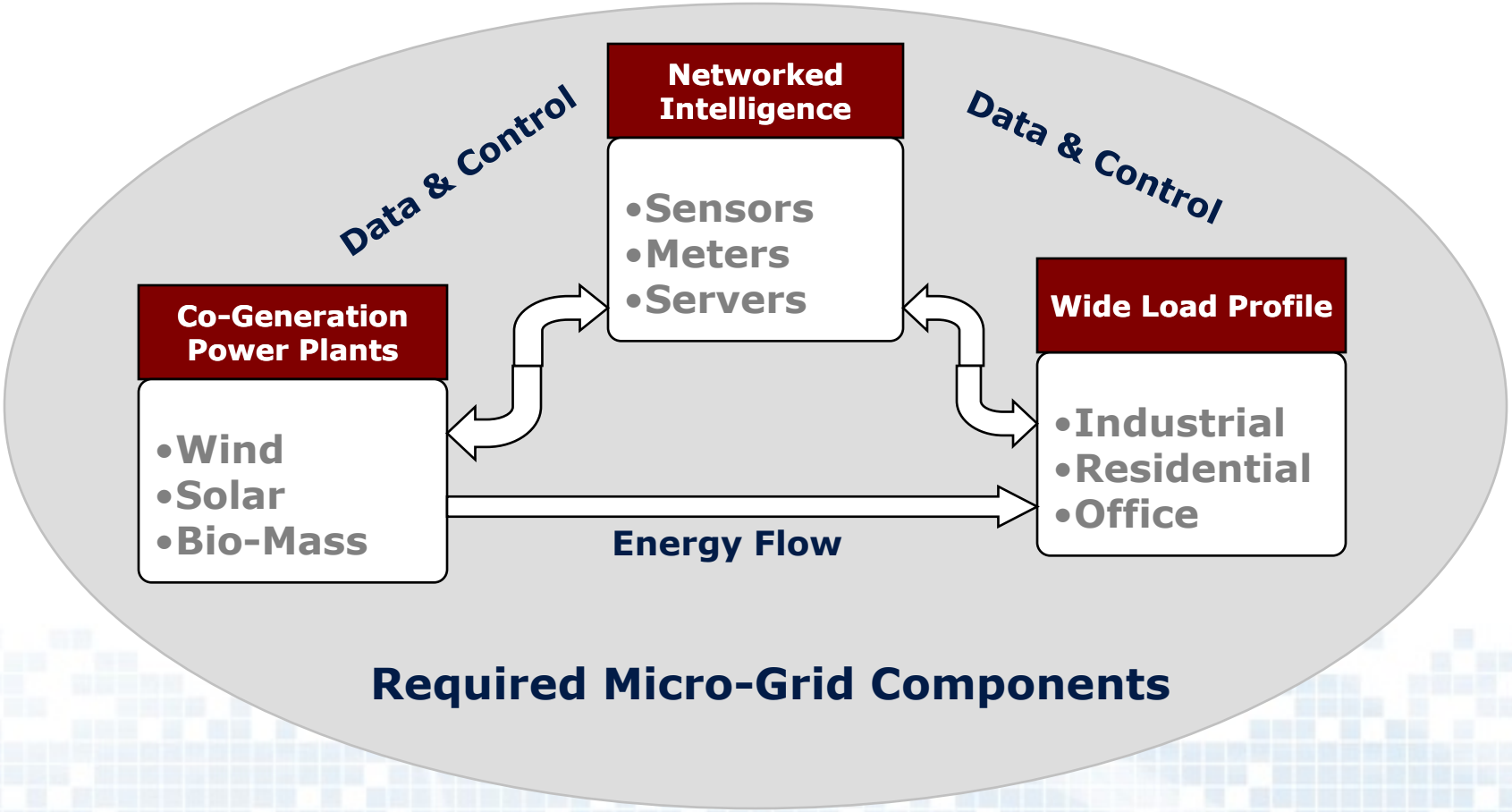
Business Barriers:

- 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:

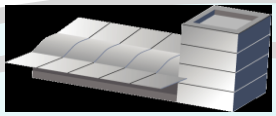
1. **Development of Intelligent Agents as building blocks of Smart Grid under an open architecture, allowing integration of various technology components into technically viable and commercially deployable solutions for utility companies' critical services.**

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.**

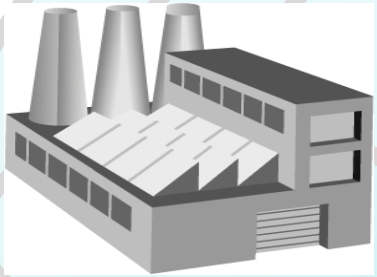
BCIT's Intelligent Micro-Grid

BCIT's Burnaby Campus

BCIT's Intelligent Micro-Grid

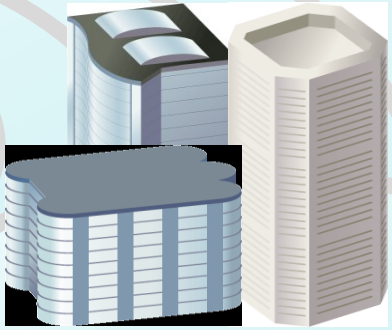


Classrooms & Workshops

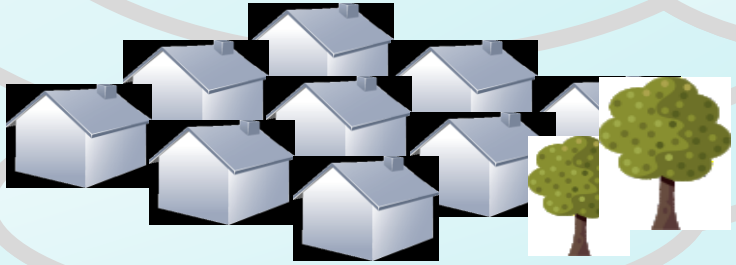


Power Plants

Internet Engineering Lab



Offices



Residences

BCIT's Micro-Grid Components

BCIT's Intelligent Micro-Grid

BCIT's Photovoltaic Tower

BCIT's Intelligent Micro-Grid

BCIT's Wind Power Deflector

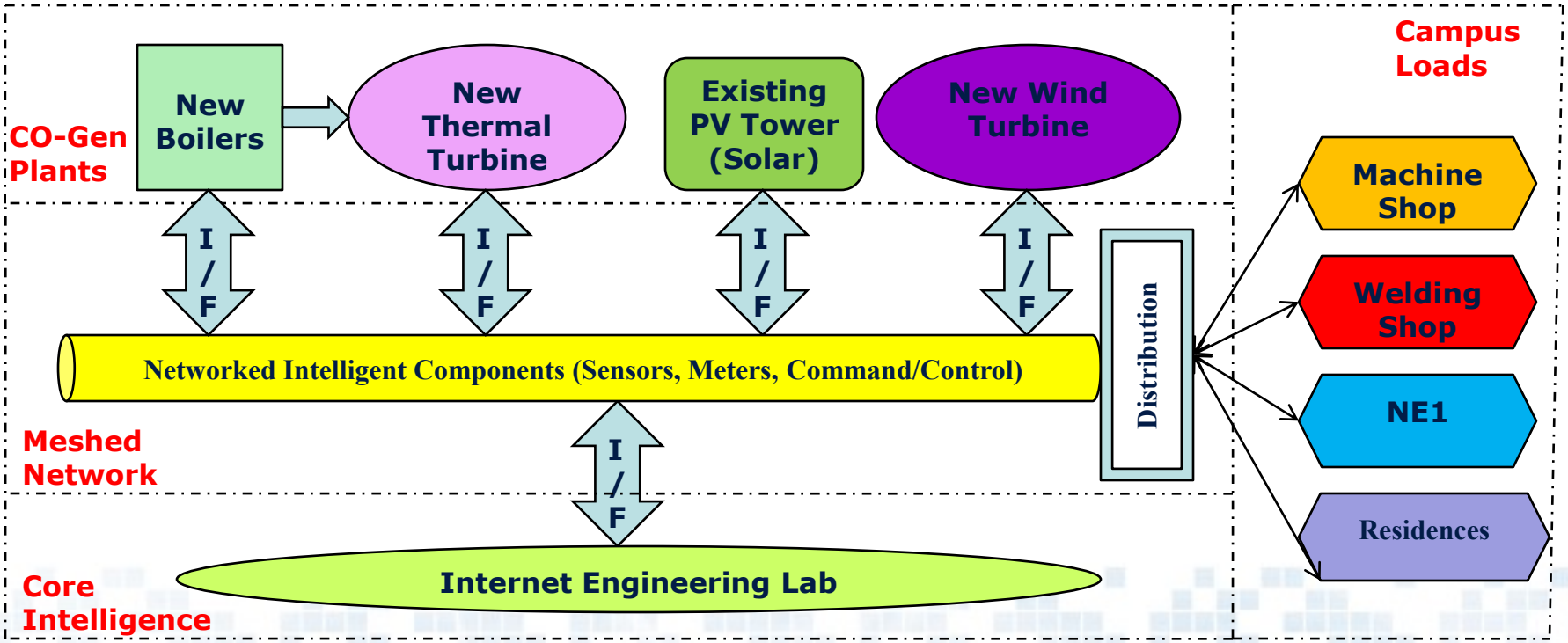
BCIT's Intelligent Micro-Grid

BCIT's Network Engineering Lab

BCIT's Intelligent Micro-Grid

Smart Metering Farm

BCIT's Intelligent Micro-Grid



Micro Grid Network Diagram

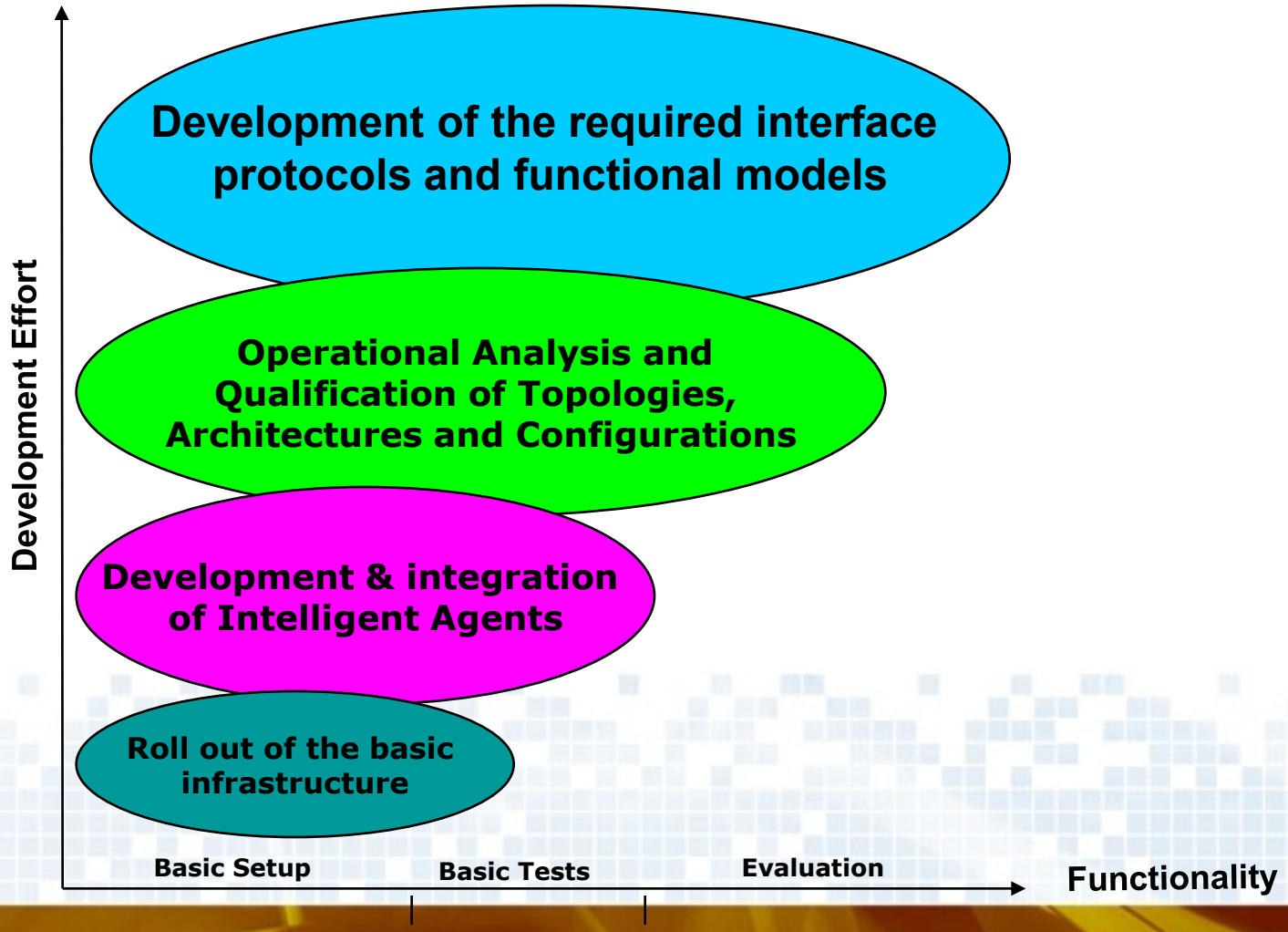
BCIT's Applied Research objectives

- **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

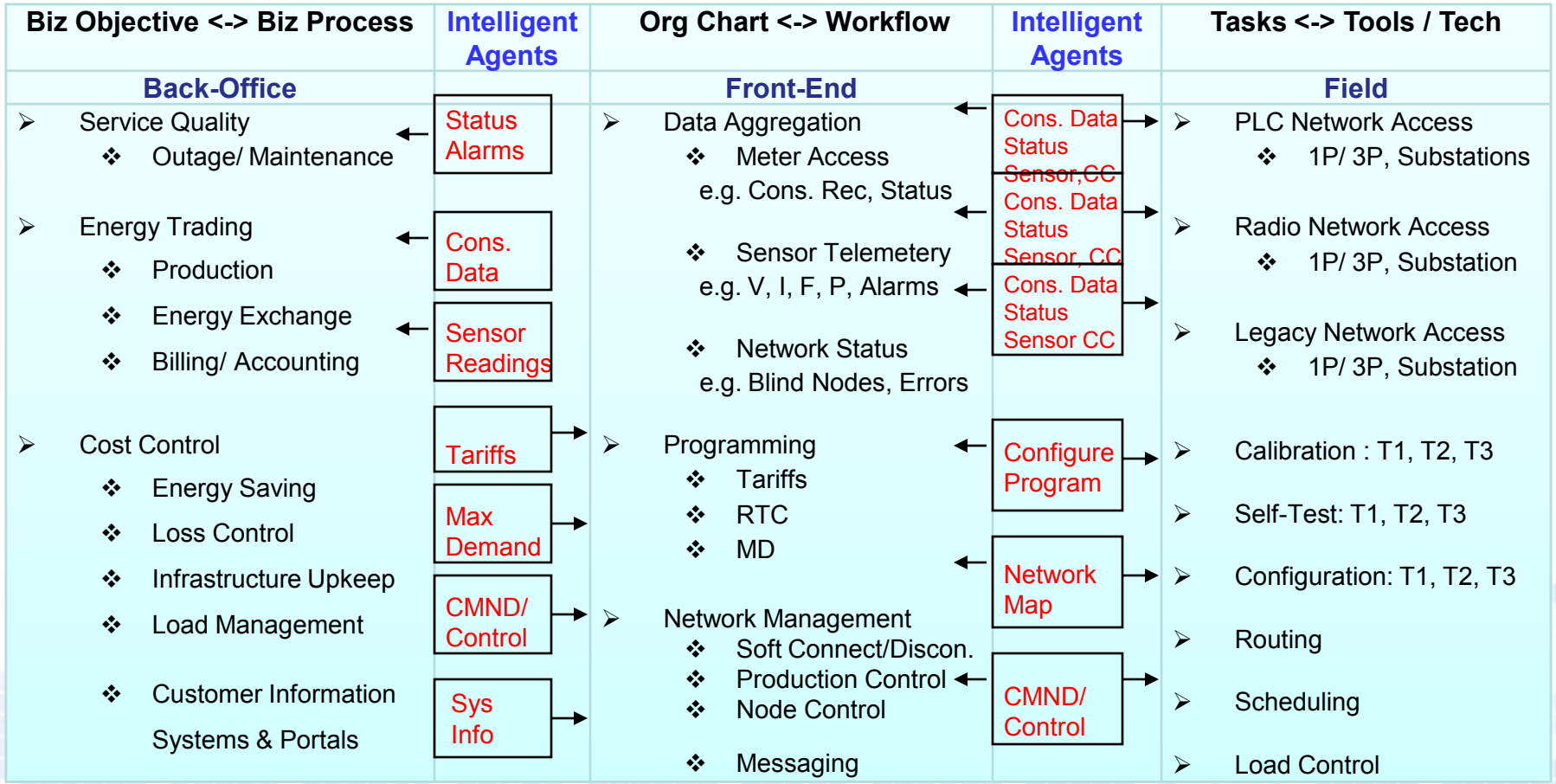
BCIT's Intelligent Agents

- 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

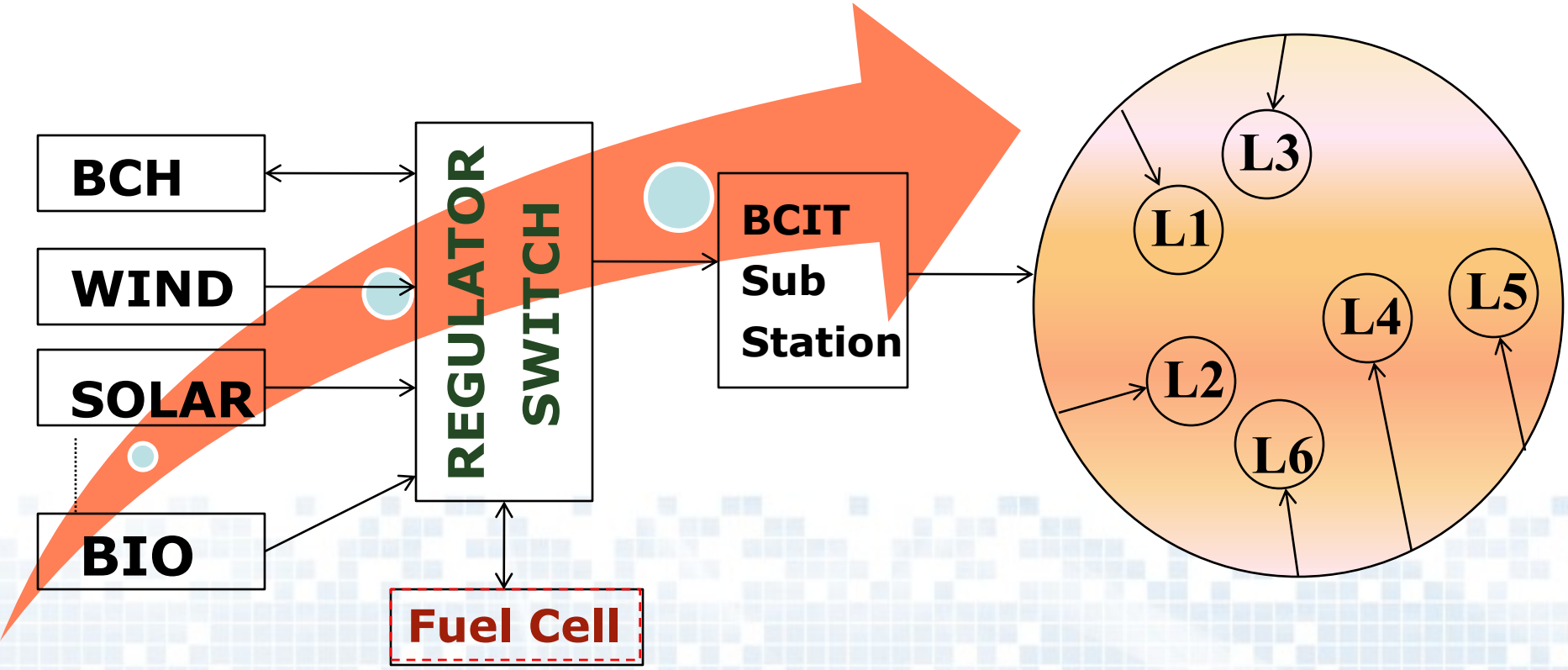
BCIT's RD&D Plan



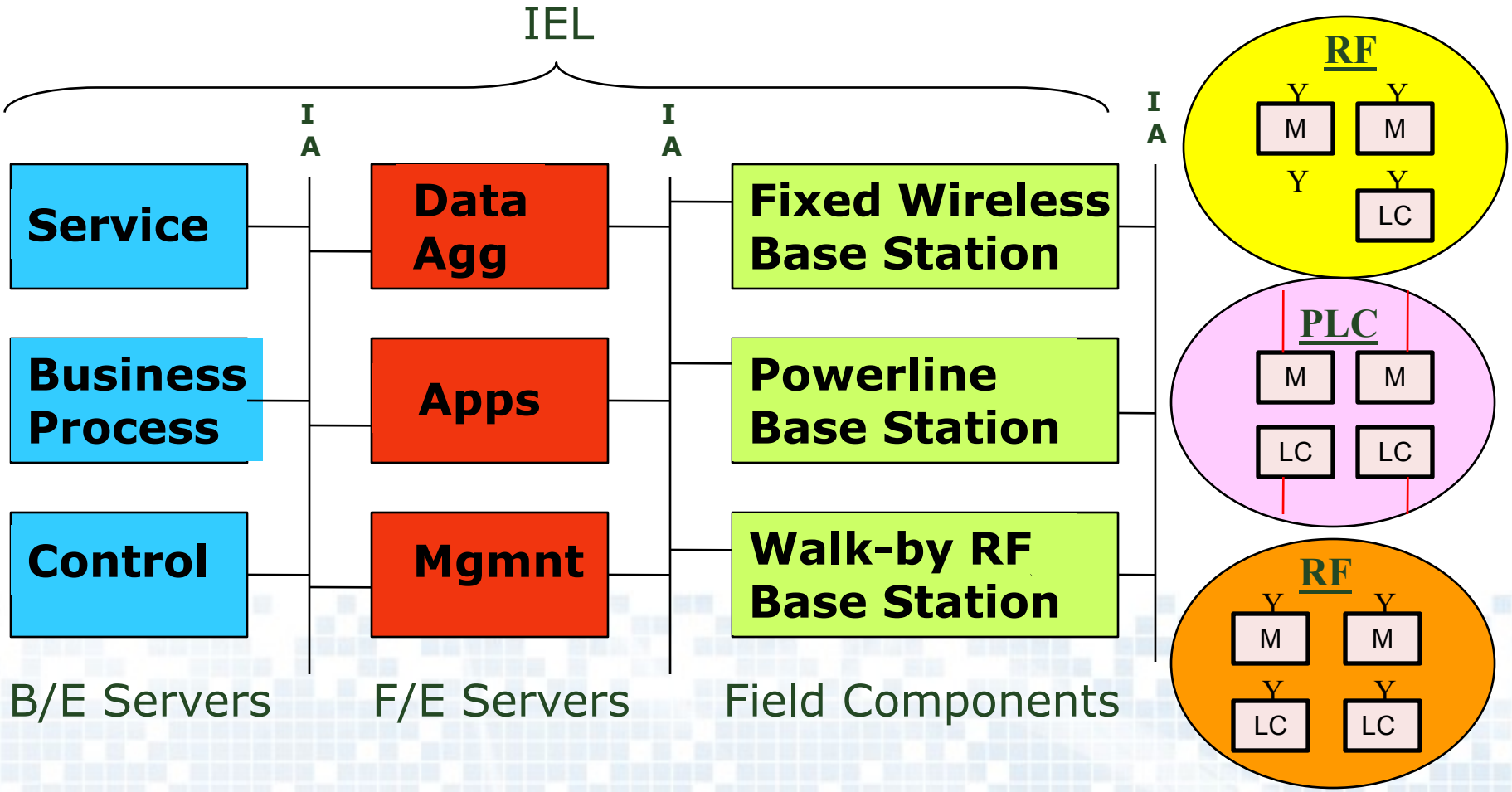
Overview of BCIT's Intelligent Agents



Grid Topology



Core Intelligence Topology



Q&A

Thank You

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