PQSynergy 2018

May 2018

Linklaser Limited

BACKGROUND

About Me – Keith Houghton

ENERGY SERVICES Ltd.

- My Company in Thailand
- Operates mainly as a Consultancy Service
- SCADA, Smart Grid, Markets, Project Management, etc.

- My Company in the UK
- Operates mainly to develop the µSCADA but also does project work

History - Linklaser

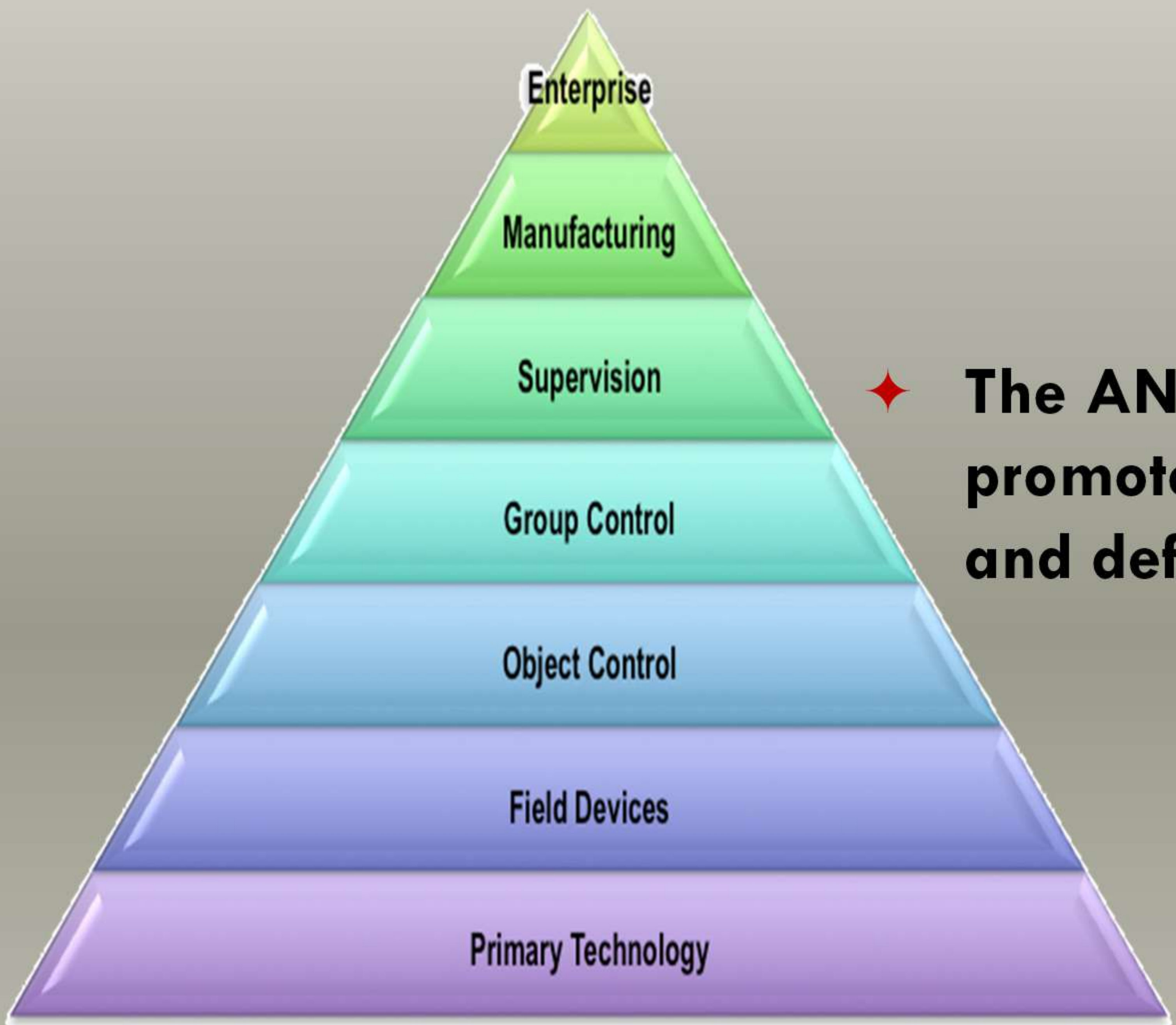
- Ran A Company With Two Friends Some Time Ago
- Produced Software For Data Acquisition And Control (SCADA / DCS)
  - 40 Man Years of software effort
  - World Class Product
  - Sold To "Blue Chip" Companies (Hoffmann la Roche, British Steel, Florida Power and Light, Manchester Ship Canal, Loveland Light and Power, Powergen, etc. etc.)
  - Competed Against Foxborough, Honeywell, ABB, Fischer Porter, Siemens, Etc.
- Originally Ran On Motorola Mc680x0 CPU's
  - Microware OS-9, 90% Written In 'C', Rest In ASM68K
- Later Product "Re-written" Under 'NIX
  - DEC Alpha And Sun Sparc Workstations
  - 100% Written In 'C', Fully POSIX Compliant
- What Should it run on now?
  - Embedded, Intel x86, Should run on QNX, OS-X, iPad, Apple TV?

Our Capabilities

- Subject matter expertise in Process Control, Instrumentation, systems design, Project management
- Association with Kuala Lumpur and Bangkok Based Universities to assist on R&D and reach out to national Utility Bases
- An industry hardened platform that has been sold to many "Blue Chip" companies around the world:
  - Hoffmann la Roche, British Steel, Florida Power and Light, Manchester Ship Canal, Loveland Light and Power. Powergen
- A product with unparalleled capacity, performance and functionality
- Industry expertize to help identify the solution set

SCADA DEFINITION

Control and Data Hierarchy



- **The ANSI/ISA 95 standard promotes good practices and defines terminology**

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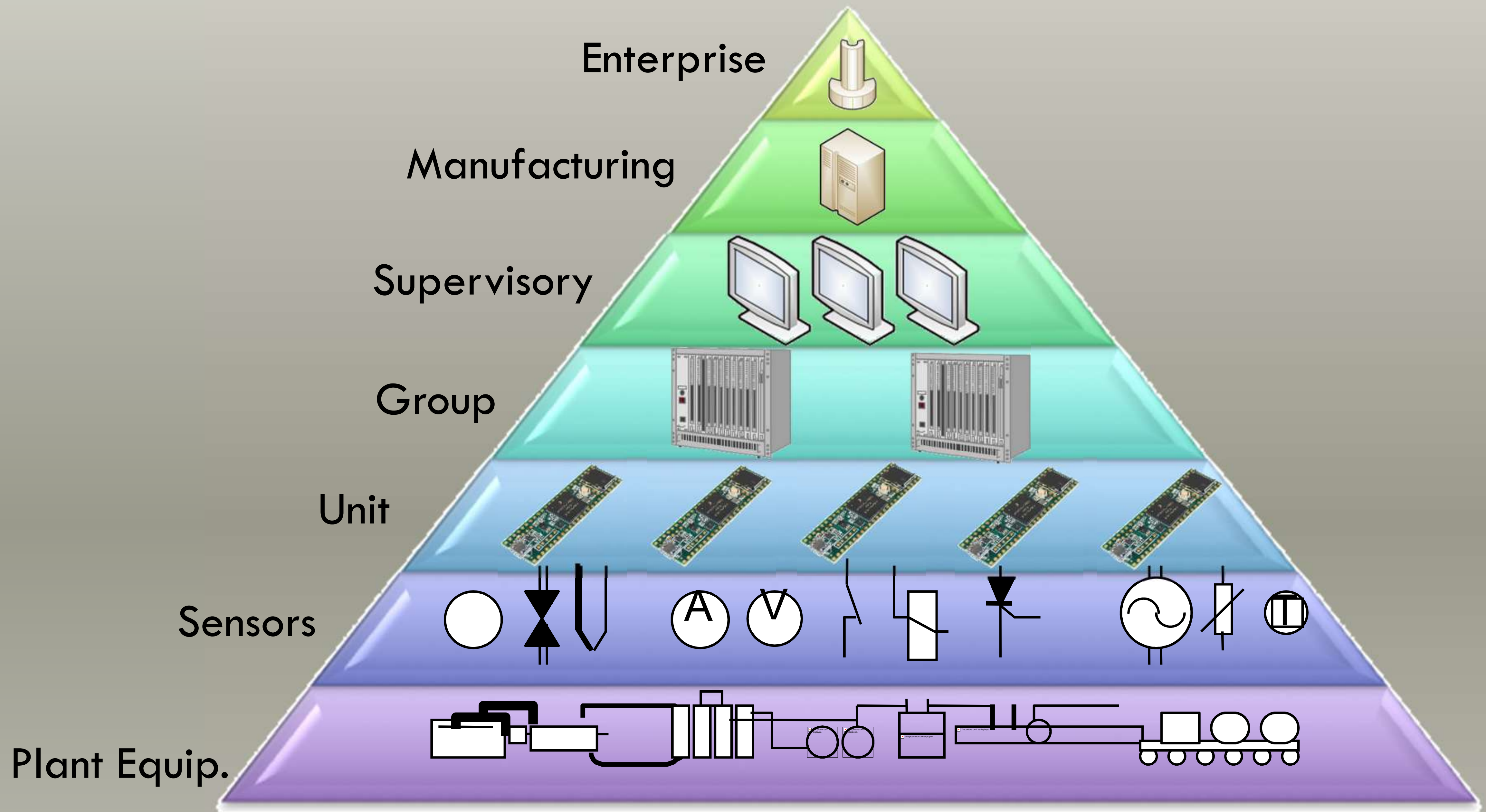
Enterprise System Hierarchy



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Evolution of the Market

- **First generation: "monolithic"**

  Early SCADA system computing was done by large minicomputers. No Common network no connectivity to other systems. protocols were strictly proprietary. Expensive back-up

- **Second generation: "distributed"**

  More like DCS systems connected through a LAN. Information near real time. Much reduced the cost as compared to First Generation SCADA. Network protocols still not standardized. Difficult to Engineer

- **Third generation: "networked"**

  Networked design, spread across more than one LAN Effectively a DCS with a single supervisor and historian.

- **Fourth generation: “embedded"**

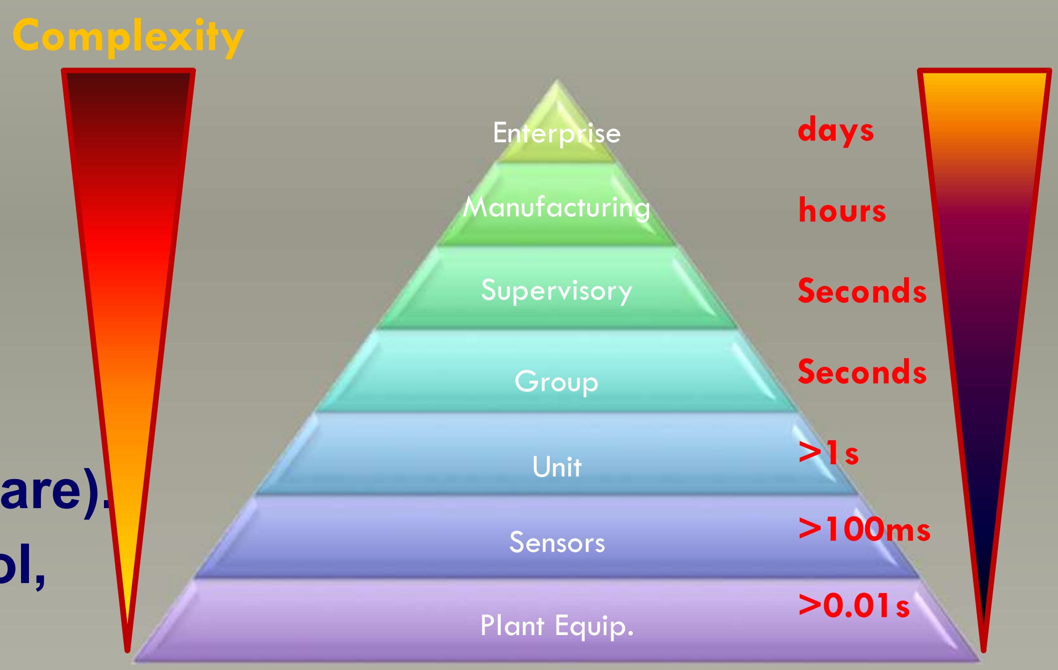
  µ-SCADA embedded in the process use open network protocols; provides comprehensive decentralization; requires a different approach to SCADA - traditional SCADA binds MMI to the data stored in specific PLC now pertinent information can be web based info.

Market Summary

- **SCADA Market: Past, present, and future**
  - ***Past*** **– Dominated by large international players (ABB, Siemens, Foxborough, Honeywell etc.). Systems costing \$100K's , proprietary, difficult to engineer.**
  - ***Present*** **– Dominated by adopters of PC's (Wonderware, FactoryLink, RSView, iFix, etc.) Systems cost \$1000's, more open, less difficult to engineer.**
  - ***Future*** **– Dominated by embedded hardware. Very low cost, open with respect to customization, adopting standards, easy to engineer. Can be utilized in areas that were previously not possible because of cost (home automation etc.)**
- **Current Situation - Very few proprietary systems; Internationals struggle against niche suppliers; costs of the basic system 100's x less; pricing very aggressive –** ***moving towards a commodity item***

Using the Data - Enterprise

- **Higher Levels**
  - **When ascending the control hierarchy, data are reduced:**
    - higher level data are created (e.g. summary information)
    - Processing and decisions becomes more complicated (requires models).
    - Timing requirements are slackened – relational database
- **SCADA level**
  - **Presentation of complex data to the human operator,**
  - **Real-time data base.**
  - **Real-time functions – trending, control, alarm and events etc.**
- **Plant Levels**
  - **Most demanding in response time.**
  - **Quantity of raw data is very large.**
  - **Processing is trivial (can be realized in hardware).**
  - **These levels are today under computer control,**



Market Needs

- The market needs a universal µ-SCADA system that will serve all the currently known needs now and its future needs (futureproof) *at a price anyone can afford.*
- The key word in the sentence above is universal. Today SCADA is used in a number of industrial areas but unfortunately these products are proprietary and lock a particular vendor in for any given end-to-end solution.

PRODUCT CAPABILITIES

Original Product Position

- **System capacity**
  - **65,000 objects**
  - **25 data acquisition links Multiple protocols**
  - **40 screens (VDU's)**
  - **Logging of 50,000 objects**
  - **Unlimited Calculations**
  - **Alarm and event handling**
  - **Customer Applications**

All updated in 1 sec

System Price > $100,000

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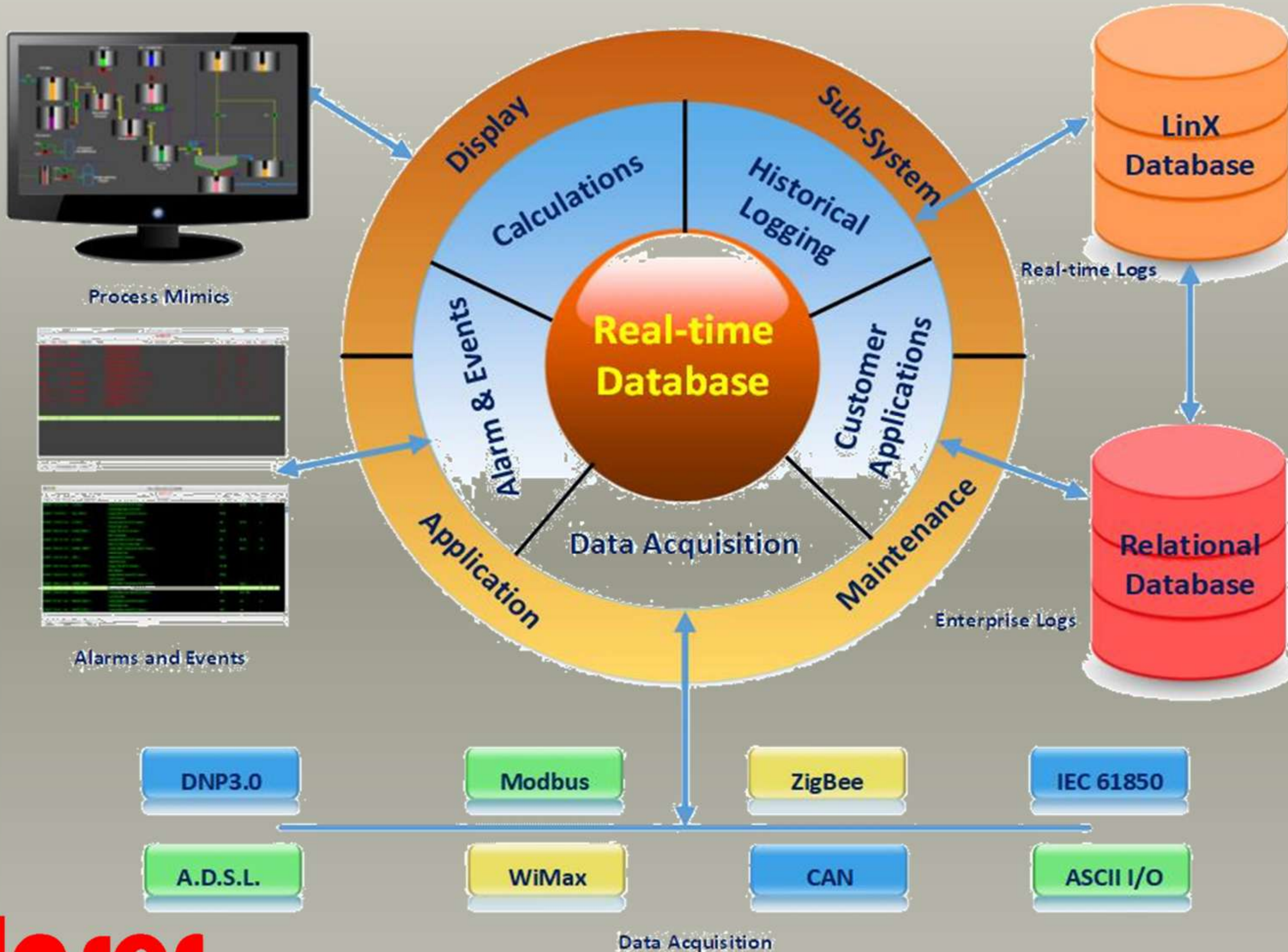
Embedded System

- **System capacity**
  - **65,000 objects**
  - **4 data acquisition links Multiple protocols**
  - **0/1 screens (VDU's)**
  - **Logging of 50,000 objects**
  - **Unlimited Calculations**
  - **Alarm and event handling**
  - **Customer Applications**

All updated in 1 sec

Target Price < $1,000

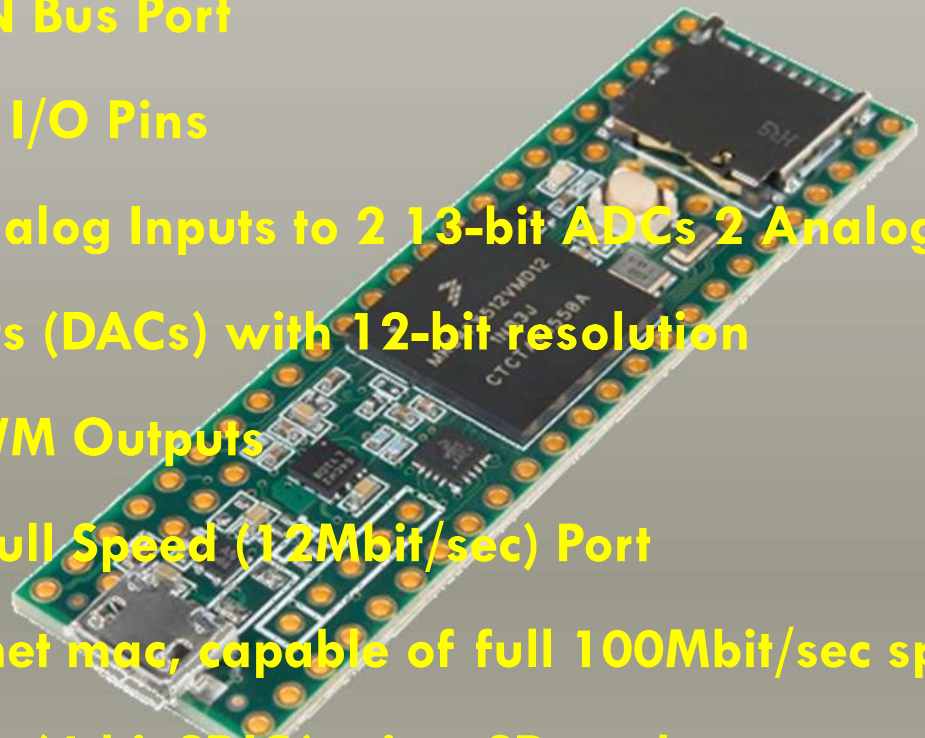
SCADA Software Structure



Embedded System Arrangement

Hardware Features

- Broadcom BCM2837B0, Cortex-A53 (ARMv8) 64-bit SoC @ 1.4GHz
- 1GB LPDDR2 SDRAM
- 2.4GHz and 5GHz IEEE 802.11.b/g/n/ac wireless LAN, Bluetooth 4.2, BLE
- Gigabit Ethernet over USB 2.0 (maximum throughput 300 Mbps)
- Extended 40-pin GPIO header
- Full-size HDMI
- 4 USB 2.0 ports
- CSI camera port DSI display port 4-pole stereo output and composite video port
- Micro SD port for loading your operating system and storing data
- 5V/2.5A DC power input
- Power-over-Ethernet (PoE) support



•120MHz ARM Cortex-M4 with FPU

•512K Flash, 192K RAM, 4K EEPROM

•1 CAN Bus Port

•16 62 I/O Pins

•25 Analog Inputs to 2 13-bit ADCs 2 Analog Outputs (DACs) with 12-bit resolution

•20 PWM Outputs

•USB Full Speed (12Mbit/sec) Port

•Ethernet mac, capable of full 100Mbit/sec speed

•Native (4-bit SDIO) micro SD card port

•I^2S Audio Port, 4-Channel Digital Audio Input & Output, 6 Serial Ports 3 SPI Ports (1 with FIFO), 3 I^2C Ports

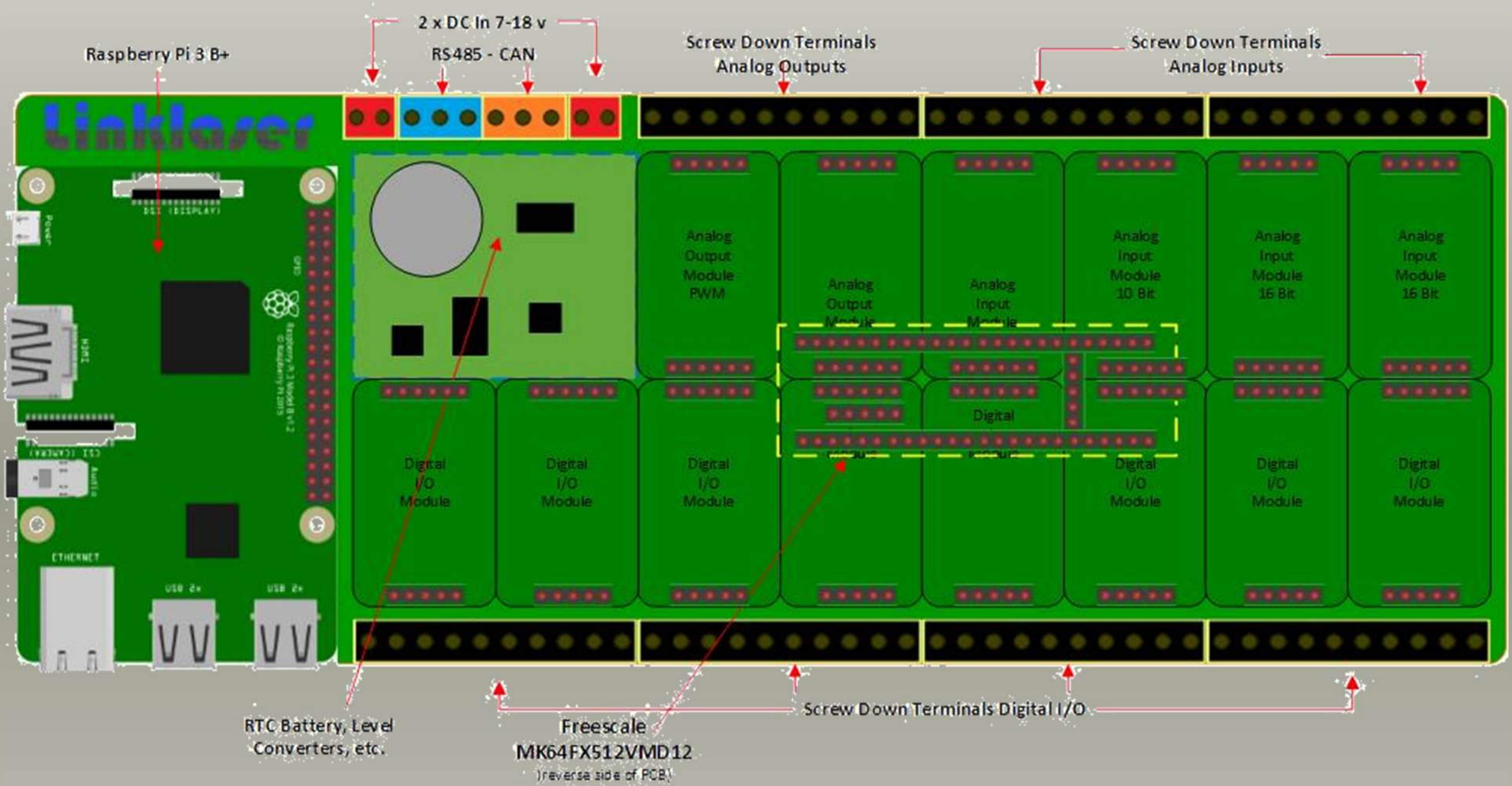
•Real-Time Clock

Then and Now

	Original MC680x0	Raspberry Pi 3B+	Indicative Difference
CPU	MC 68030 25MHz, 32 bit, separate FPU, 18 MIPS	1200 MHz Quad Core, 64 bit, Integrated FPU 2870 MIPS	160 x the processing speed
Memory	4 Mbytes RWM	1GByte RWM *	250 x acpacity
HDD	250MByte SCSI, 20MB/s	32 Gbyte Micro SD, 100 MB/s	128x Capacity, 5x speed
GPU	None	Integrated@ 400 MHz	
Conns	Serial, Parallel, Ethernet	Serial, Ethernet, Wi-Fi, SPI, I2C, TWI, USB, Bluetooth, etc., etc.	
PCB Price	$2,500** ($4,000 today)	$50 (Board + TF)	80 x Cheaper
System	$23,500 ($37,500 today)	$750	50 x Cheaper

*some shared with GPU **Plus OS

Example Board Development

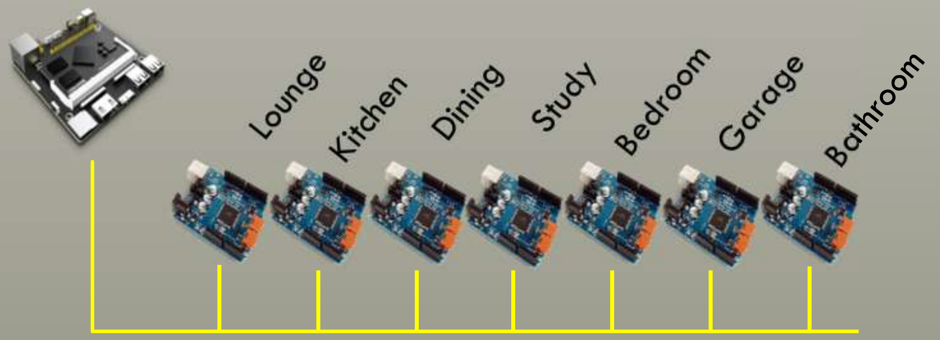


Vertical Markets/Segments

- **Initial Vertical Markets**
  - **Electrical Utilities**
    - Smart Grid, Microgrid Control, AMI, Public lighting, EV Charging, Substation Automation etc.
  - **Building Automation**
    - Office Blocks, Shopping Malls, Educational Establishments
  - **Work with target End-users to conduct Pilot projects**

Applications – Where it Fits

- **Smart Grid**
  - Data Concentrators (AMI etc.),
  - MicroGrid Controllers,
  - Public Lighting,
  - Electric Vehicle Charging (And Billing)
  - Off-grid Generation,
  - Distribution Automation,
  - Demand Side Management
- **Building Automation**
  - Home Automation dozen or so I/O – NO
  - Home Automation couple of dozen I/O per room – YES
- **Any General Process Control Application**
- **Traditional SCADA Applications (Water, Telecoms, Gas, Electricity, etc.)**



µSCADA Systems for MicroGrid

What the Micro Grid Control Needs

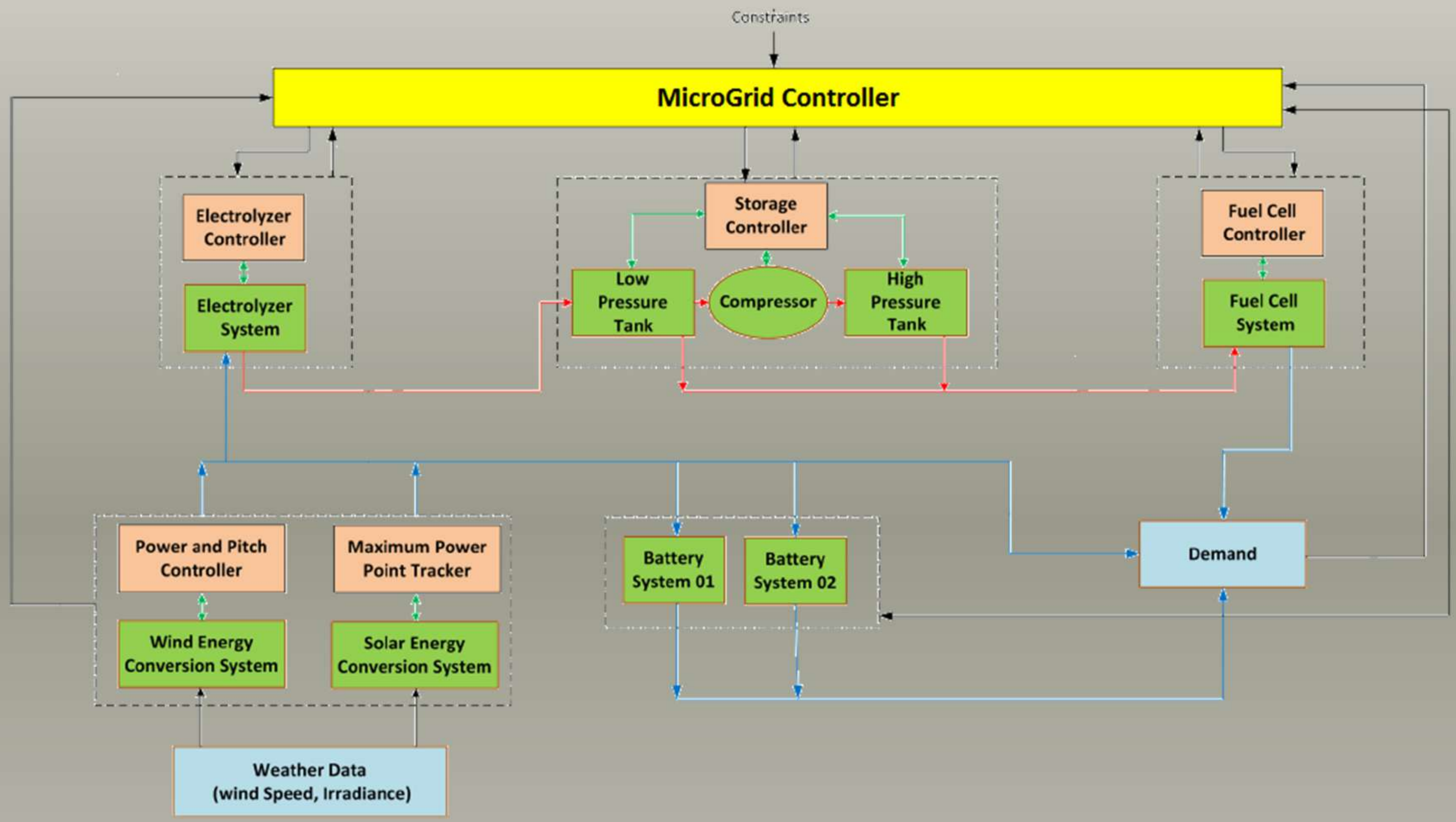
A System that can provide

- energy management within and outside of the distribution system
- Differing control philosophies (hierarchical or distributed)
- islanding and interconnected operation
- Support for different types type of networks (ac or dc, fixed or variable frequency)
- management of power flow constraints, voltage and frequency
- device and interface response and intelligence requirements
- protection functions for networks of variable configurations
- open communications infrastructure
- Adoption of open and commercial protocols and hardware

Additional Functions beyond “SCADA”

- Additional functions for Islanded Control
- Modelling software, forecasts for weather, load etc.
- Unit commitment / economic dispatch
- RES / Storage Management
- Optimal Power Flow
- Fault Restoration and Isolation
- Security Monitoring / Assessment
- Demand side Management based on Pricing signals
- Data Delivery to stakeholders
- Integration to Energy Markets
- Resource usage and Billing

Example MicroGrid Arrangement



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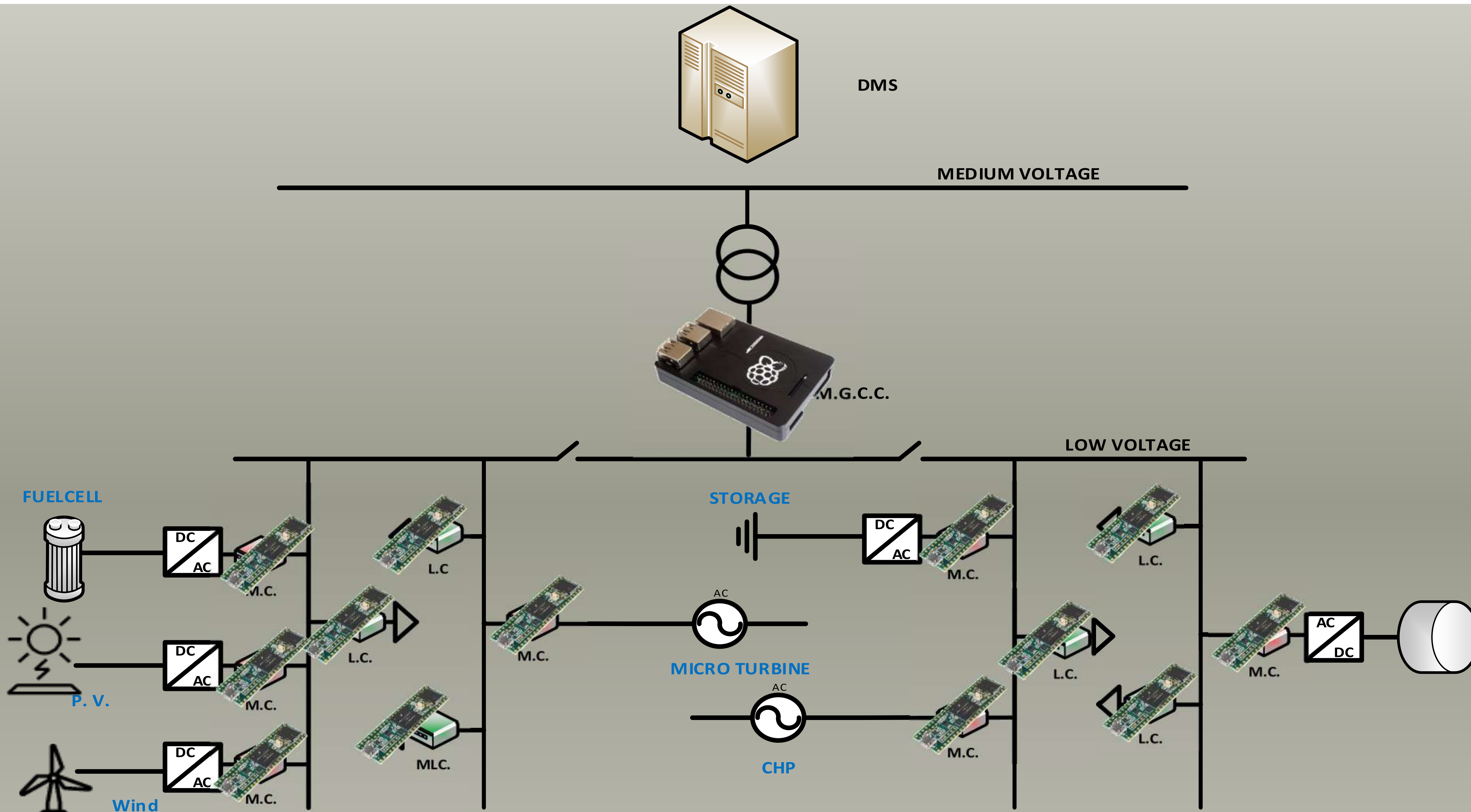
MicroGrid Embedded Fit



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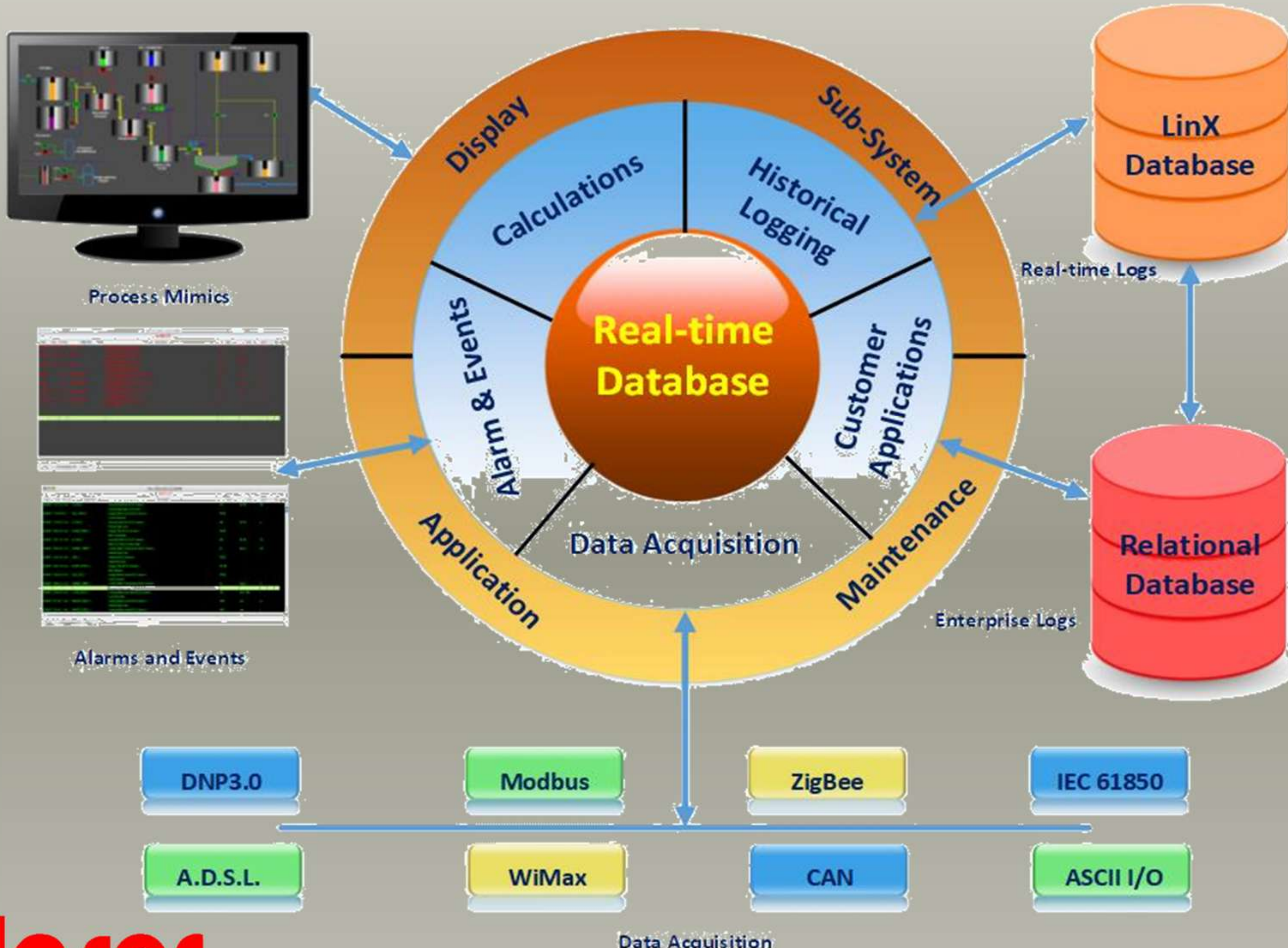
Applicable Standards

Standard	Application
AMI-SEC System Security Requirements	AMI and Smart Grid End-to-end Security
ANSI C12.19/MC1219	Revenue Metering Information Model
BACnet ANSI ASHREA 135-2008/ISO 16484-5	Building Automation
DNP3	Substation and Feeder Automation
IEC 60870-6 / TASE.2	Inter-Control Centre Communications (ICCP)
IEC 61850	Substation Automation and Protection
IEC 61968 / 61970	Application level Energy Management System Interfaces
IEC 62351 Parts 1-8	Information Security for Power System Control Operations
IEEE C37.118	Phasor Measurement Unit (PMU) communications
IEEE 1547	Physical and electrical interconnections between utility and DG
IEEE 1686-2007	Security for intelligent electronic devices (IED's)
NERC CIP 002-009	Cyber security standards for the bulk power system
NIST Special Publication (SP) 800-53, NIST SP 800-82	Cyber security standards and guidelines for federal information systems, including those for the bulk power system
Open Automated Demand Response (Open DR)	Price responsive and direct load control
Open HAN	HAN device communication, measurement and control
ZigBee/ HomePlug Smart Energy Profile	HAN Device Communications and Information Model

Traditional Suppliers

- Main Suppliers' Strengths
  - Have an established market share with many references
  - Have loyal customers who have invested much time in their products
- Main Suppliers' Weaknesses
  - Competition tends to focus on one application e.g. factory automation
  - Data handling capacity tends to be limited and product prices are based on capacity
  - Solutions are designed to tie in the customer to a given (proprietary) solution set – not readily customizable
  - Prices for basic currently available SCADA start at roughly double the target price and goes to many times the cost as functionality / capacity increases
  - Functionality and connectivity is limited and units are not scalable

SCADA Software Structure



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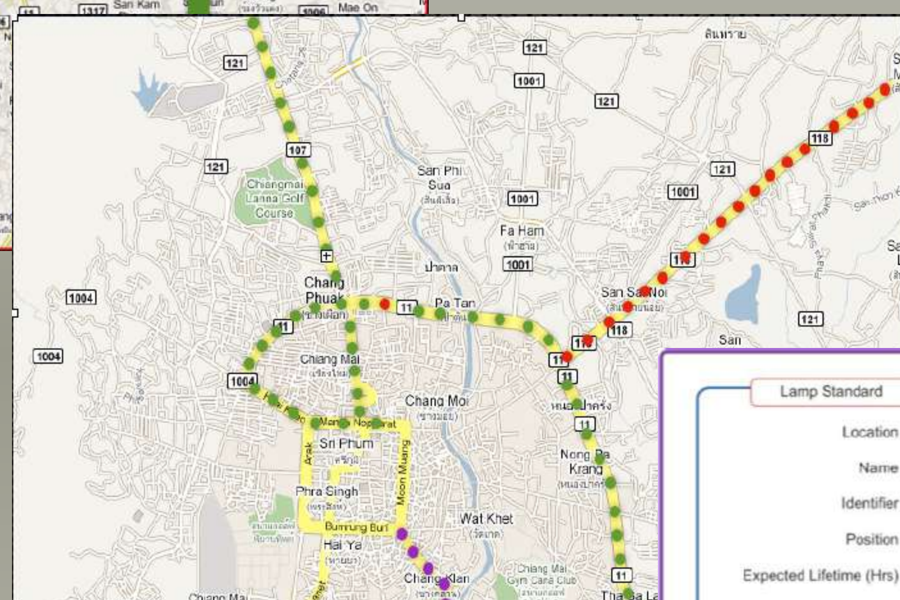
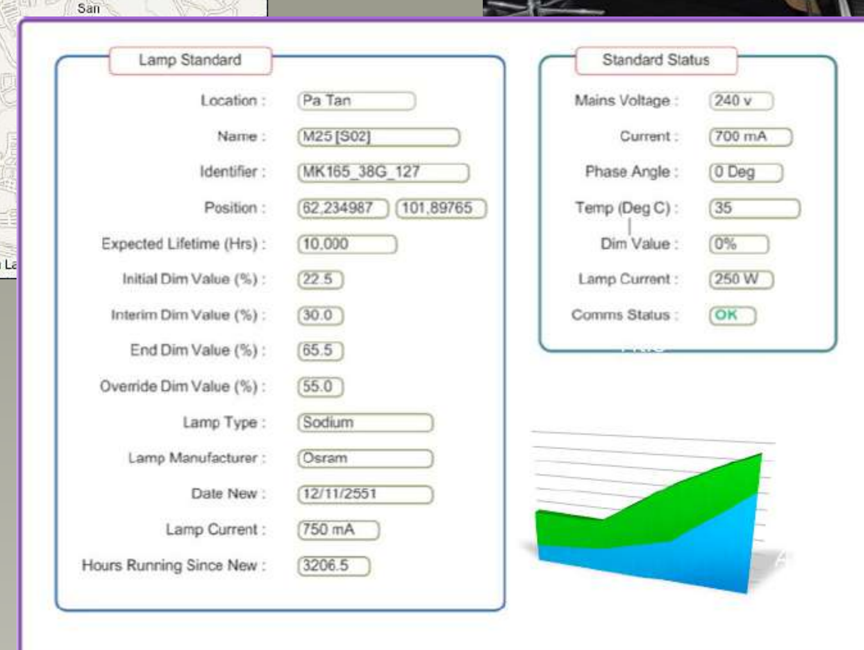
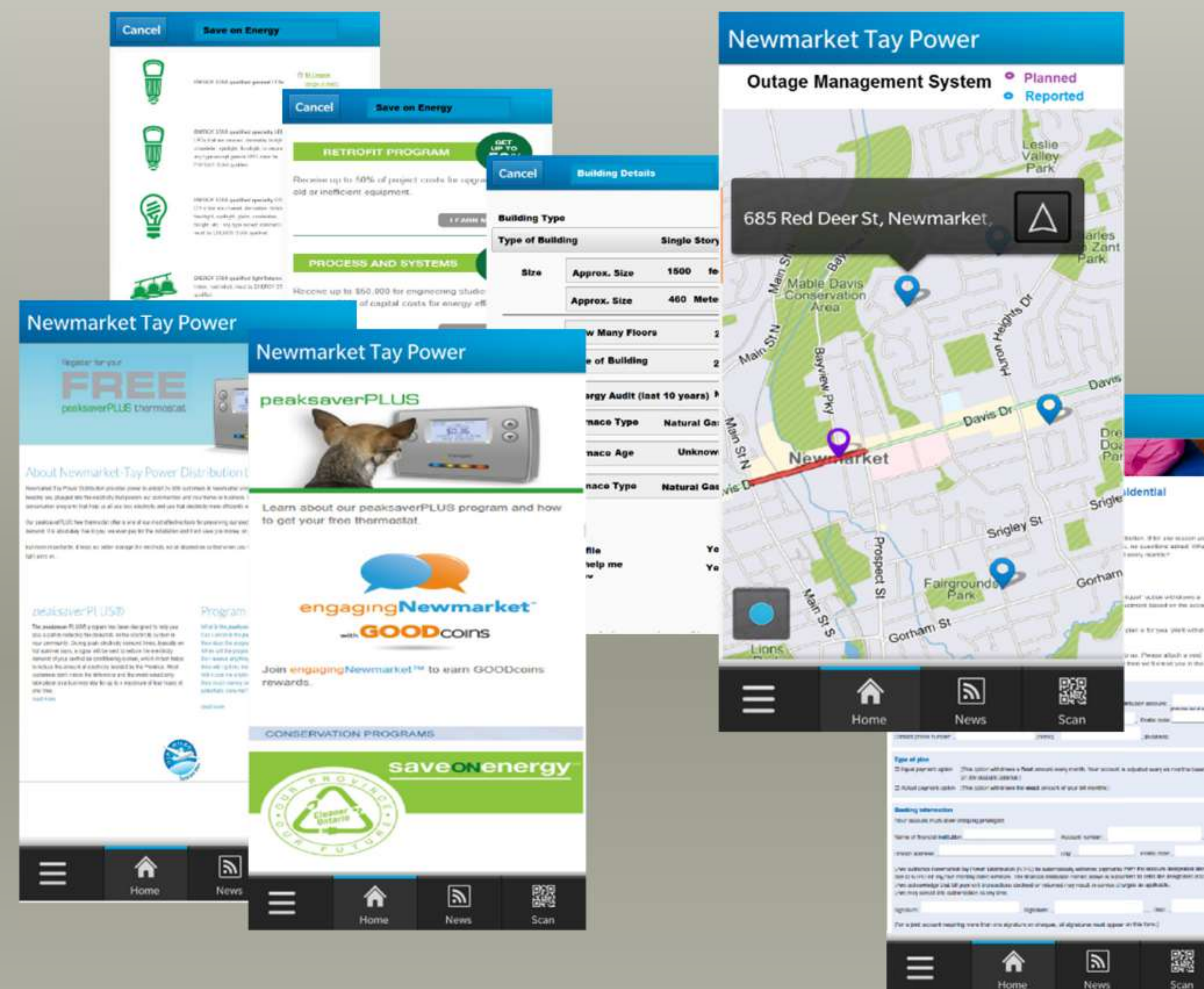
Data Presentation – Asset Mgmt.





Mobile Applications



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Mobile Apps - Capabilities

- Personalized Information
- Cross Platform
- Private, Secure
- Location Data
- Other Utility Information
- Energy Efficiency Initiatives
- Outage Information
- Share data with others
- Customize the output
- Multiple language Support

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Conclusions

- We need software that is a "Rock Solid" foundation
- Basic SCADA shall require Absolutely No Programming Knowledge
- Open System Allows the possibility to Customize
- Can be Applied to all Smart Grid Applications
- Can be used for "Blind" Applications
- Facilitates Enterprise integration
- Is Secure and Cost Effective
- Is Futureproof

Thanks for Listening

Any Questions / Comments Can
Be Addressed To

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