ARCH ROCK

IP-Enabled Smart Objects : The Next Generation of Services

Patrick Grossetete
Product Management and Customers Solutions
patrick@archrock.com

Green IT Trends

ARCH ROCK

- **ICT**
  - 2% of global CO2 (up to 6% - 2020)
  - Same as civil aviation (up to 3% - 2020)
  - but ~7% of worldwide GDP

Green Protocol WG
The New Internet. A Green Technology.

2

IP Convergence

ARCH ROCK Innovation's

Converged Devices and Services

Web 2.0, P2P, VoIP, IP/TV, VoD, "Things" Smart Meters,…

IP Infrastructures

Converged Networks

Data, Audio, Voice, Video, "Things"

Wired, Wireless – Fixed, Mobile

Smart Grid

3

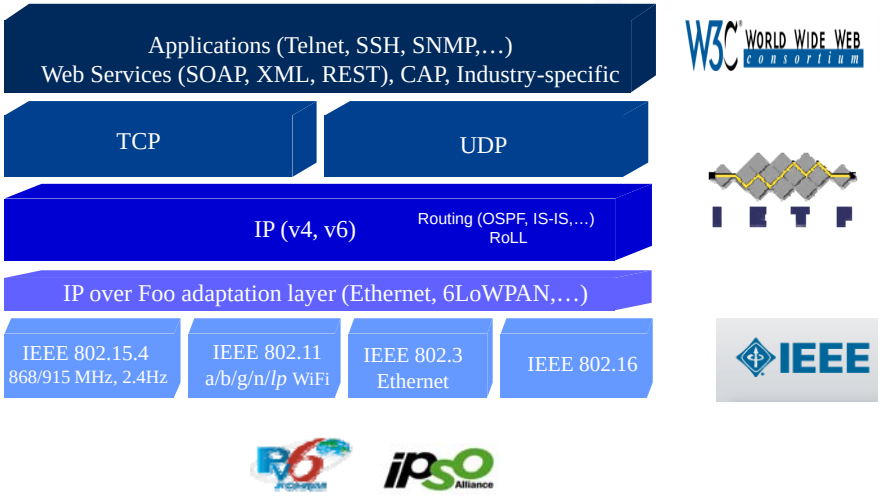
The IP Benefits for "Things"

ARCH ROCK

- **The Internet – a demonstration of very large scale IP deployment**
  - Critical traffic such as voice and TV already running over IP
  - Most "industrial" (wired) standards support an IP option, ie: Modbus, BACnet and LonWorks
  - Has already demonstrated its capabilities to work over low bandwidth links
- **Future proof architecture and extensive interoperability – Interoperability**
  - IP runs over any IP network link – wireless (WiFi, 3G, WiMax,…) and wired (Ethernet, Sonet/SDH, serial,…) - Single PHY/DATALINK layer will never fit all of the needs and requirements
  - 6LoWPAN (RFC 4944) defines IP over IEEE 802.15.4
- **End-to-end reliability in addition to link reliability – TCP/UDP Transport protocols**
- **Established application level data model and services**
  - HTTP/HTML/XML/SOAP/REST, Application profiles
  - Established naming, addressing, translation, lookup, discovery
- **Established network architectures for higher-level services**
  - load balancing, caching, mobility
- **Established security**
  - Network design and policy determines access, not the technology
  - Authentication, access control, and firewall mechanisms
- **Established network management tools – Ease management and troubleshooting**
  - Ping, Traceroute, SNMP, … OpenView, NetManager, Ganglia, …

4

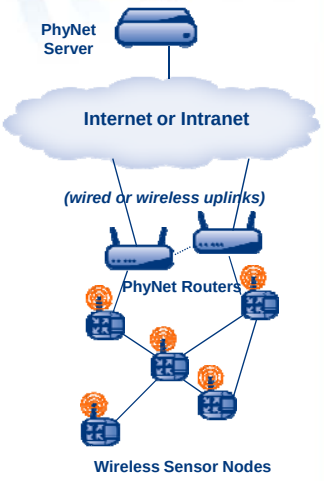
IP – an Open Architecture



IP & Wireless Sensor Network

- **Network of small-footprint computers**
- **Optimized for long-life on low power**
- **Equipped to sense physical data**
- **Networked using low-power radio**

- **Function:**
  - Sense any measurable physical parameter
    - Light, motion, chemicals, proximity, biometrics
  - Form "LoWPAN = Low power Wireless Personal Area Network" and communicate
    - Automatic meshing and routing over radio
  - Apply user-defined business logic
    - Sampling, summarizing, reporting events
- **Form:**
  - Node (Processor, Radio, Storage) + Sensors
  - Embedded OS, Networking, Applications
  - Servers and Routers interfacing with Enterprise IT systems



RFC 4944 – IPv6 Header Compression

- Standard IPv6 header (40 bytes) vs Entire 802.15.4 MTU (127 bytes)
  - Often data payload is small, Pay for only what you use
- By virtue of having joined the same 6LoWPAN network, devices share some state.
- The IPv6 header values are expected to be common on 6LoWPAN networks, so the HC1 header has been constructed to efficiently compress them from the onset
- Next header: UDP, TCP, or ICMP in a compressed IPv6 Header

IPv6 Header Compression

Version = IPv6	Traffic Class = 0	Flow Label = 0	
Payload Length In 802.14.4 header or fragment header		Next Header In HC1 byte	Hop Limit = uncompressed
Source Address: Link Local + IID derived from 802.15.4 header			
Destination Address: Link Local + IID derived from 802.15.4 header			

7

RFC 4944 Header Compression Examples

IEEE 802.15.4 header (22 bytes)

Dst PAN ID	Source EUI-64 00-17-3B-00-33-33-44-44	Src PAN ID	Source EUI-64 00-17-3B-00-11-11-22-22

Compressed IPv6/UDP header (7 bytes) FE80::0217:3B00:1111:2222 -> FE80::0217:3B00:3333:4444

DSP	HC1	HC2	Hop Limit	UDP ports	UDP Cksm

Compressed IPv6/UDP header (23 bytes) FE80::0217:3B00:1111:2222 -> FF02::1

DSP	HC1	HC2	Hop Limit	Destination address (FF02::1)	UDP ports	UDP Cksm

Compressed IPv6/UDP header (31 bytes)

DSP	HC1	HC2	Hop Limit	Source Prefix 2001:0db8:cafe:cafe::/64)	Destination Prefix 2001:0db8:beef:beef::/64	Destination IID 0221:1234:5678:6543	UDP ports	UDP Cksm

2001:0db8:cafe:cafe:0217:3B00:1111:2222 -> 2001:0db8:beef:beef: 0221:1234:5678:6543

8

IP WSN Eco-System

ARCH ROCK

Solutions

Arch Rock Energy Optimizer (AREO)

Building Data Center Wiring Closet

Eco-System Partners
Environmental
Municipal streets,
High-end agriculture

Applications

Data Presentation and Analysis
Software as a Service and Appliance solutions
Open and standard file formats , eg. Energy Monitoring, thermal monitoring, air quality,…

Data & Network Management

Data Collection,
Temporary Storage,
and Export layer

Infrastructure

6LoWPAN routers and Relay Nodes
Low power meshed network, IPv4 & IPv6
Flexibility, Scalability, Availability, Security, Manageability

Sensing Nodes

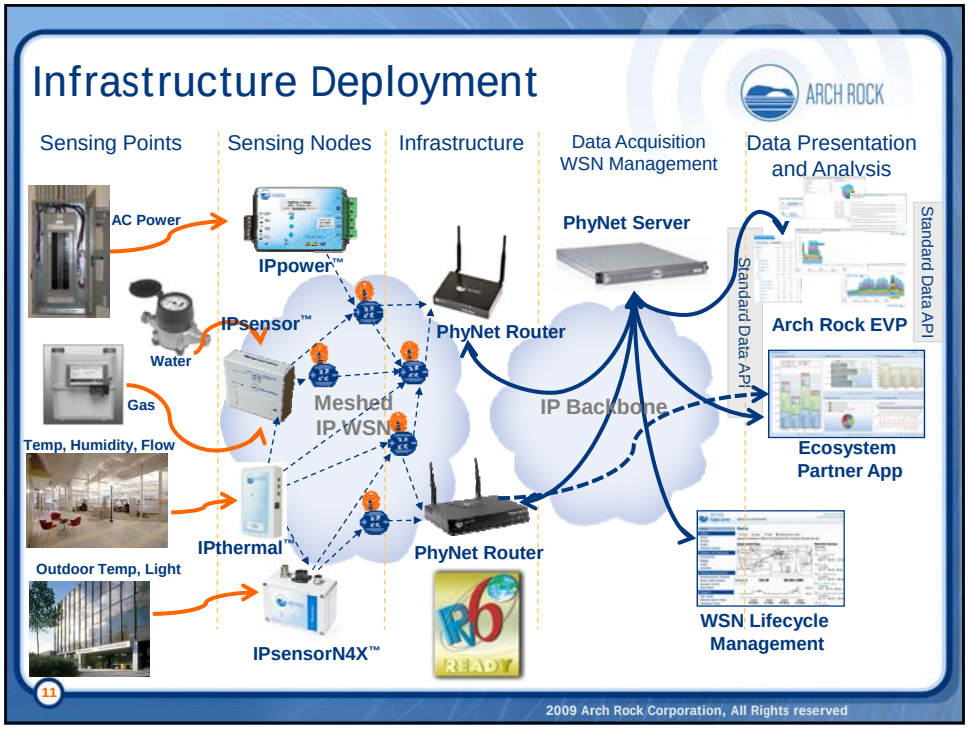
Sensor-specific nodes
Expandable nodes
Embeddable OEM nodes

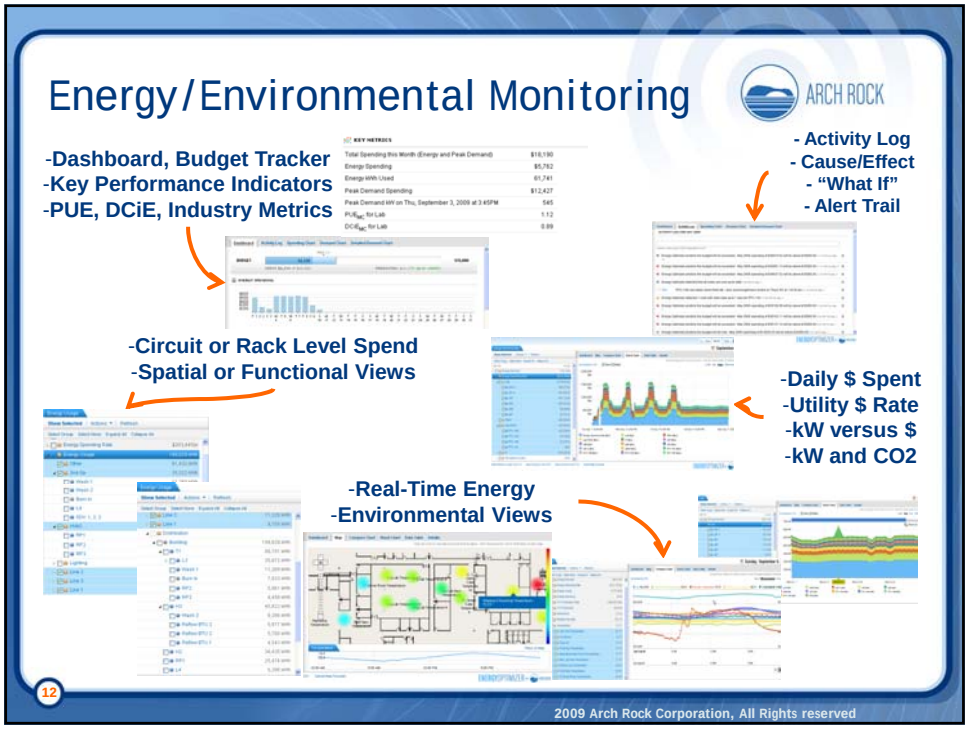
Key Drivers of Fine-Grained and Real-Time Energy Visibility

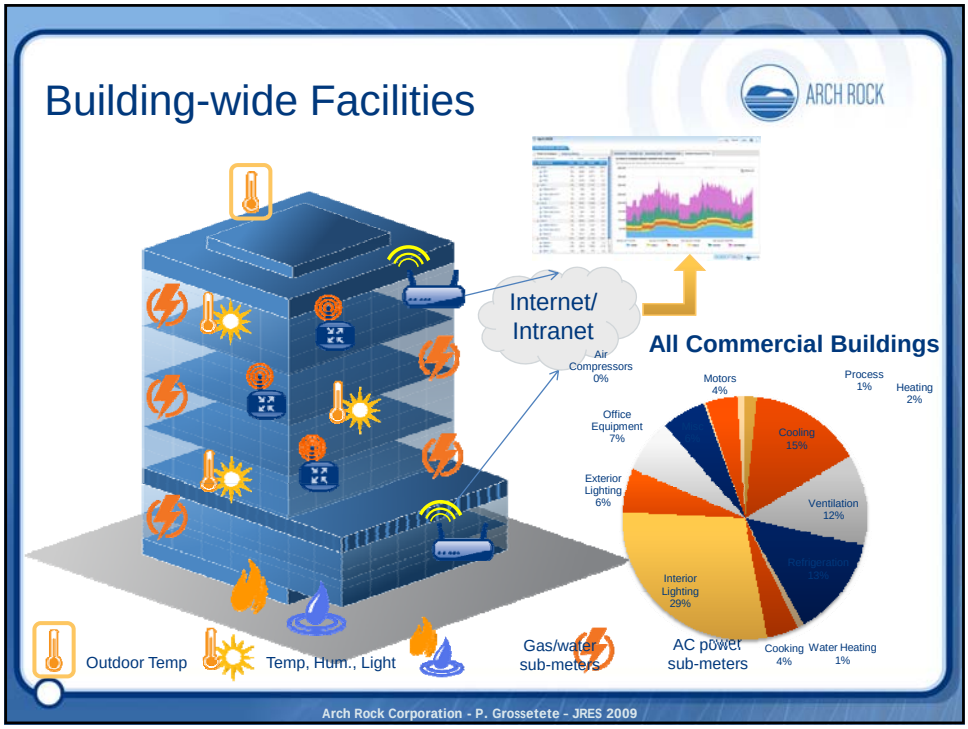
ARCH ROCK

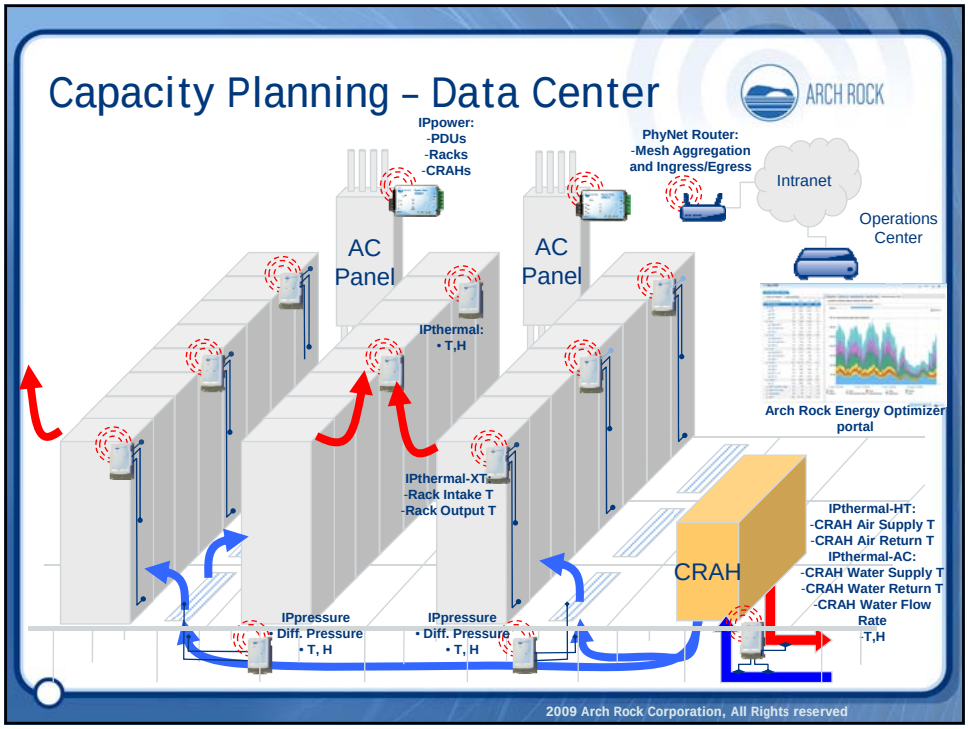
- Cutting energy spending
  - *Ongoing resource reduction translates to real, substantial savings*
- Leveraging utility tariffs
  - *Time-of-use, demand ratchet avoidance, demand/response readiness*
- Extending life of facilities
  - *Leverage the complete potential of existing power or cooling capacity*
- Complying with mandates
  - *US (EISA 07, EPAct 05), CA (AB32), FR (Environmental "Grenelle")…*
- Achieving certifications
  - *Ongoing adherence to building standards: EnergyStar, LEED, THPE…*
- Committing to sustainability
  - *Brand strength, stake-holder loyalty and cultivation of goodwill*

10


Infrastructure Deployment
ARCH ROCK
Sensing Points
Sensing Nodes
Infrastructure
Data Acquisition
WSN Management
Data Presentation
and Analysis
AC Power
IPpower™
PhyNet Server
Standard Data API
Arch Rock EVP
IPsensor™
Water
PhyNet Router
Gas
Meshed
IP WSN
IP Backbone
Ecosystem
Partner App
Temp, Humidity, Flow
IPthermal™
PhyNet Router
Outdoor Temp, Light
WSN Lifecycle
Management
IPsensorN4X™
11
2009 Arch Rock Corporation, All Rights reserved


Energy/Environmental Monitoring
ARCH ROCK
-Dashboard, Budget Tracker
-Key Performance Indicators
-PUE, DCiE, Industry Metrics
- Activity Log
- Cause/Effect
- "What If"
- Alert Trail
-Circuit or Rack Level Spend
-Spatial or Functional Views
-Daily $ Spent
-Utility $ Rate
-kW versus $
-kW and CO2
-Real-Time Energy
-Environmental Views
12
2009 Arch Rock Corporation, All Rights reserved

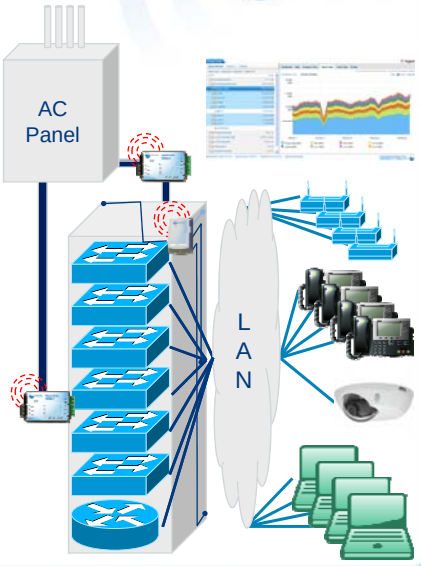

Building-wide Facilities
ARCH ROCK
Internet/
Intranet
All Commercial Buildings
Air Compressors 0%
Motors 4%
Process 1%
Heating 2%
Office Equipment 7%
Cooling 15%
Exterior Lighting 6%
Ventilation 12%
Refrigeration 13%
Interior Lighting 29%
Cooking 4%
Water Heating 1%
Outdoor Temp
Temp, Hum., Light
Gas/water sub-meters
AC power sub-meters
Arch Rock Corporation - P. Grossetete - JRES 2009


Capacity Planning – Data Center
ARCH ROCK
IPpower:
-PDUs
-Racks
-CRAHs
PhyNet Router:
-Mesh Aggregation
and Ingress/Egress
Intranet
Operations
Center
AC
Panel
AC
Panel
IPthermal:
• T,H
Arch Rock Energy Optimizer
portal
IPthermal-XT:
-Rack Intake T
-Rack Output T
CRAH
IPthermal-HT:
-CRAH Air Supply T
-CRAH Air Return T
IPthermal-AC:
-CRAH Water Supply T
-CRAH Water Return T
-CRAH Water Flow
Rate
-T,H
IPpressure
• Diff. Pressure
• T, H
IPpressure
• Diff. Pressure
• T, H
2009 Arch Rock Corporation, All Rights reserved

Capacity Planning – Telecom Room

ARCH ROCK

- Monitoring energy and environmental data for concentration of networking equipments
  - ✓Wiring closets (switches, firewall, VPN concentrator, Appliances,…
  - ✓Telco locations (PoP, IX,…) with routers, broadband or mobile services equipments
- Increase of PoE usage in wiring closets
  - ✓IP phones, camera, AP, netbook,…
  - ✓PoE:12W on 802.3af -> 24W on 802.3at/ per port or on a switch with 384 ports PoE = ~11KW
- Environmental monitoring
  - ✓Temp, Humidity
  - ✓Noise level,…



P. Grossetete - JRES 2009

IP WSN in Municipal Streets Services

ARCH ROCK

- Embedding IP WSN nodes in Parking meters reducing overall cost of operation and enabling new services.
  - – IP WSN GPRS or WiFi routers to connect a cluster of parking meters to a central office
  - – IPrelay Power Amplifier nodes when required

- Additional sensor nodes detecting vehicles and advertising free parking slots through City's services
- City's environmental air quality could be added through additional sensor nodes
  - – Alarms, surveillance, treaty verification

16

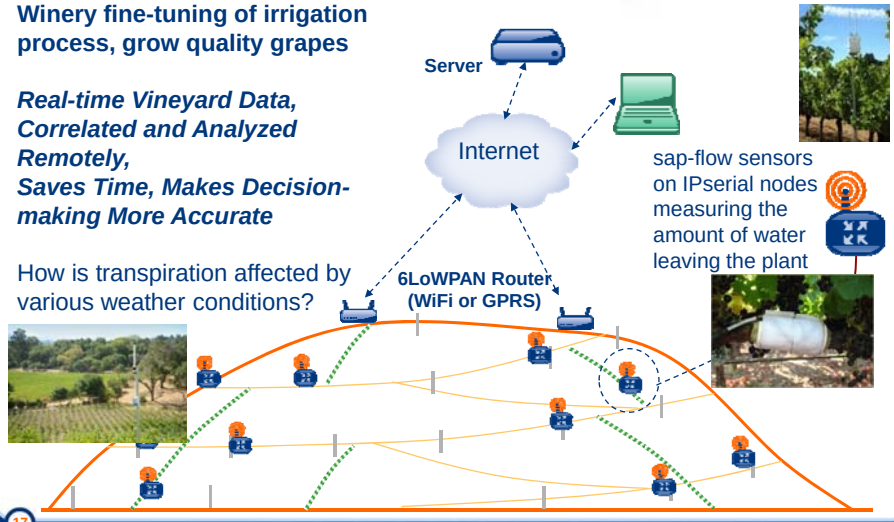
IP WSN in High-end Agriculture

http://www.networkworld.com/newsletters/wireless/2009/030209wireless2.html

Winery fine-tuning of irrigation process, grow quality grapes

Real-time Vineyard Data, Correlated and Analyzed Remotely, Saves Time, Makes Decision-making More Accurate

How is transpiration affected by various weather conditions?



17

Collaborative Internet Sensors Communities

- Web 2.0 – Collaboration – Cloud Computing
  - Education & Research, Interest Groups, Public Information
- Let's get your imagination developing the usage!
  - http://ec.europa.eu/information_society/policy/rfid/documents/c_archrock.pdf

18

Leading the Internet of Things to the Internet of Services

- Open Standards (IEEE, IETF, W3C)
- Forum member (IPv6, IPSO, Zigbee)
- Scalable Architecture & Solution
- Open Platform
- Interoperability (Data Link, Network, application Layers)
- Investment Protection

References

- http://www.archrock.com
- http://www.ipso-alliance.org
- Global IPv6 Strategies case study
  - http://www.globalipv6strategies.com