



ARCH ROCK

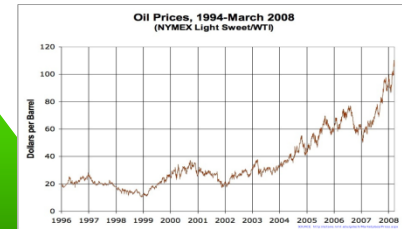
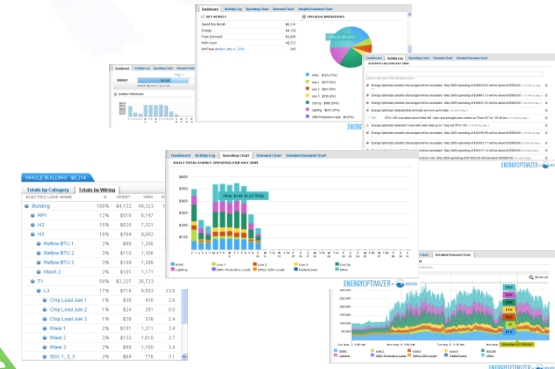
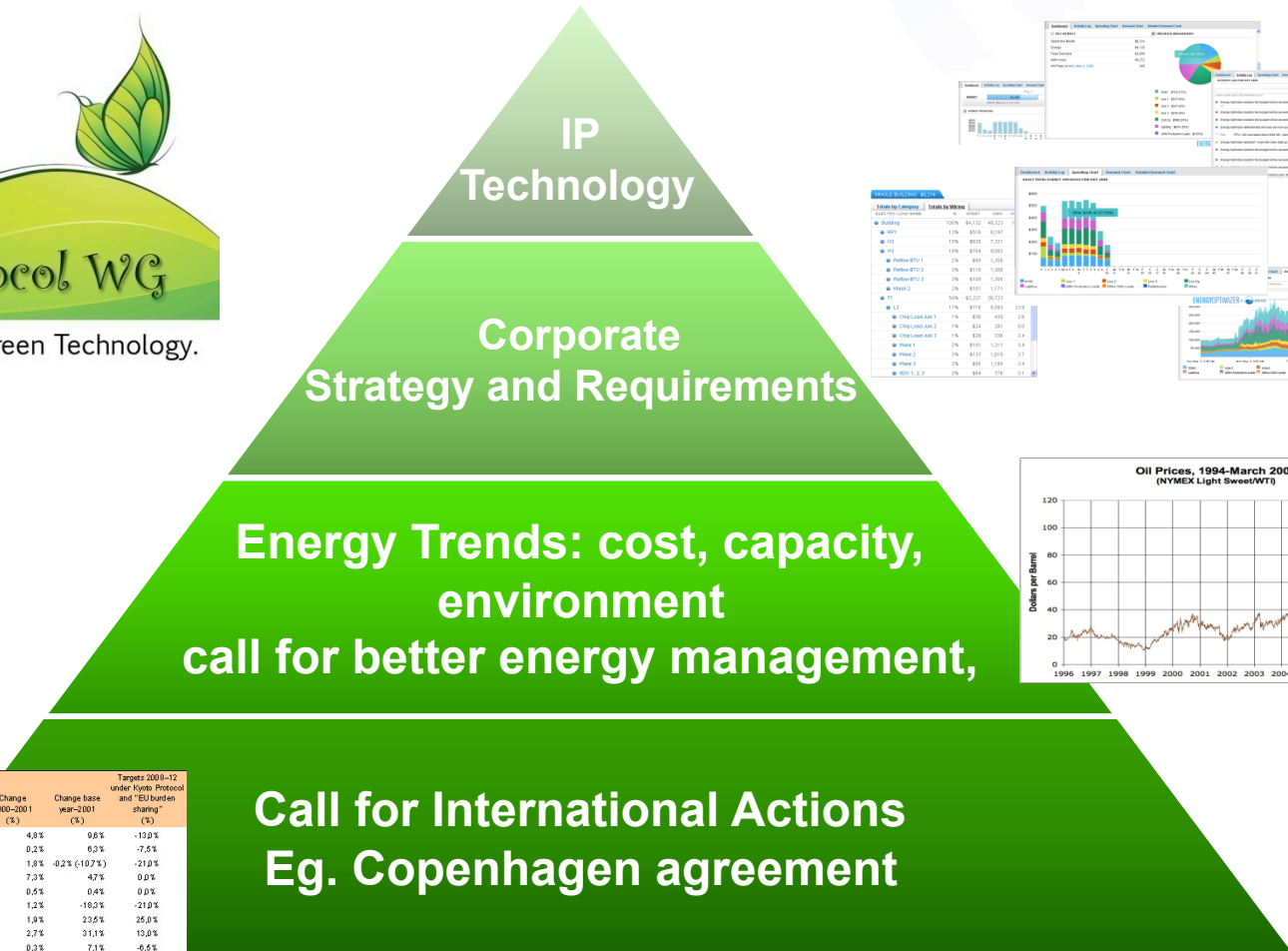
# IP-Enabled Smart Objects : The Next Generation of Services

Patrick Grossetete  
Product Management and Customers Solutions  
[patrick@archrock.com](mailto:patrick@archrock.com)

# Green IT Trends

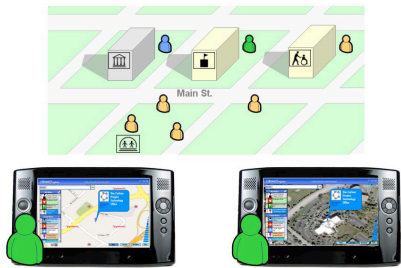


The New Internet. A Green Technology.



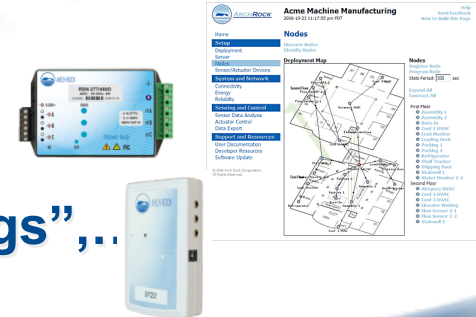
MEMBER STATE	Base year (million tonnes)	2001 (million tonnes)	Change 2000-2001 (%)	Change base year-2001 (%)	Targets 2009-12 under Kyoto Protocol and "EU burden sharing" (%)
Austria	78.3	95.9	4.8%	9.8%	-12.0%
Belgium	141.2	150.2	0.2%	0.3%	-7.5%
Denmark	69.5	69.4	1.8%	-0.2% (-10.7%)	-21.0%
Finland	77.2	80.9	7.3%	4.7%	0.0%
France	558.4	550.8	0.5%	0.4%	0.0%
Germany	1218.2	993.5	1.2%	-18.2%	-21.0%
Greece	107.0	132.2	1.9%	23.5%	25.0%
Ireland	65.4	70.0	2.7%	31.1%	12.0%
Italy	599.3	545.4	0.3%	7.1%	-6.5%
Luxembourg	10.9	6.1	1.2%	-44.2%	-29.0%
Netherlands	211.1	219.7	1.2%	4.1%	-6.0%
Portugal	61.4	83.8	1.9%	36.4%	27.0%
Spain	289.9	382.8	-1.1%	32.1%	15.0%
Sweden	72.9	70.5	2.2%	-3.3%	4.0%
United Kingdom	747.2	657.2	1.3%	-12.0%	-12.0%
EU-15	4064.0	4109.3	1.0%	-2.3%	-8.0%

# IP Convergence



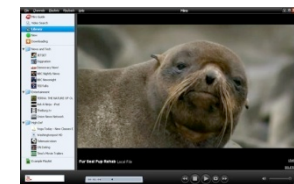
## Converged Devices and Services

Web 2.0, P2P, VoIP, IP/TV, VoD, "Things", ..



# IP Infrastructures

## Converged Networks Data, Audio, Voice, Video, "Things" Wired, Wireless – Fixed, Mobile



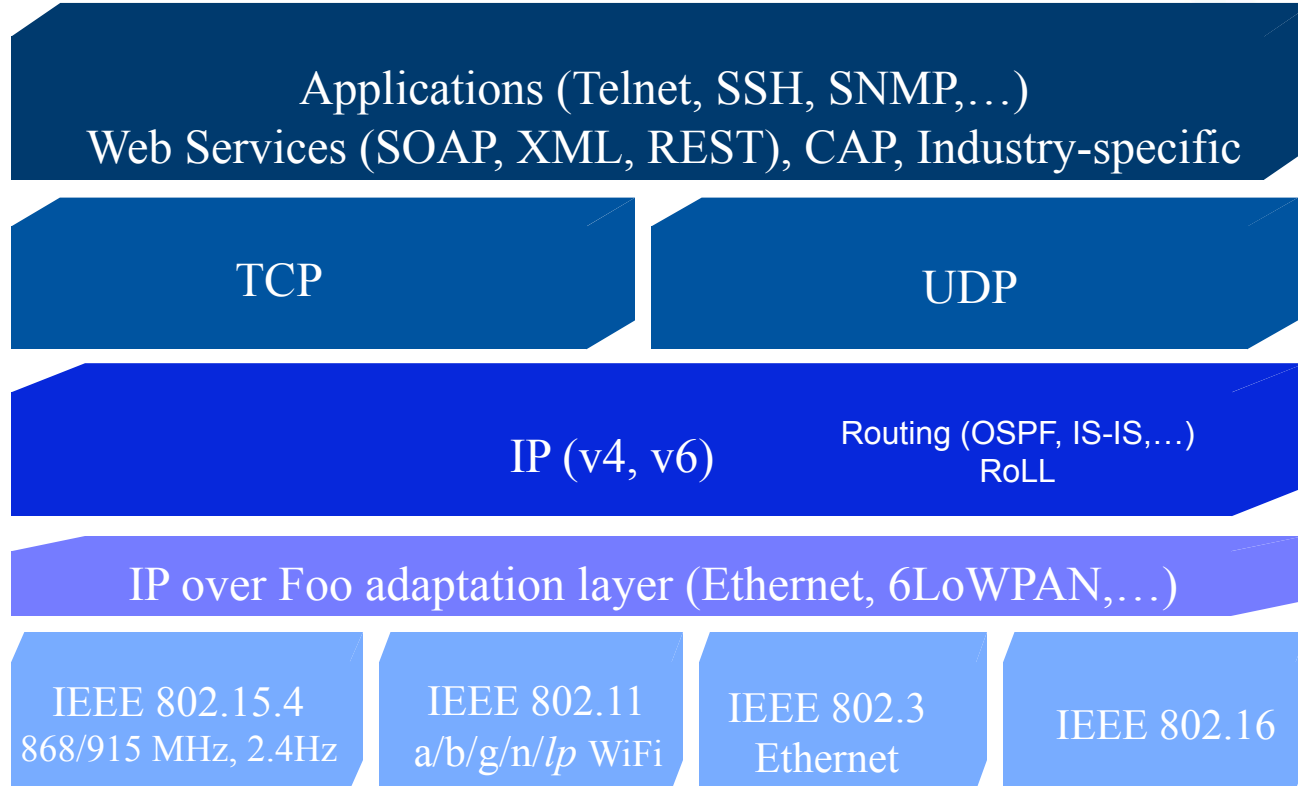


# The IP Benefits for “Things”

- **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, ...



# IP - an Open Architecture



# IP & Wireless Sensor Network

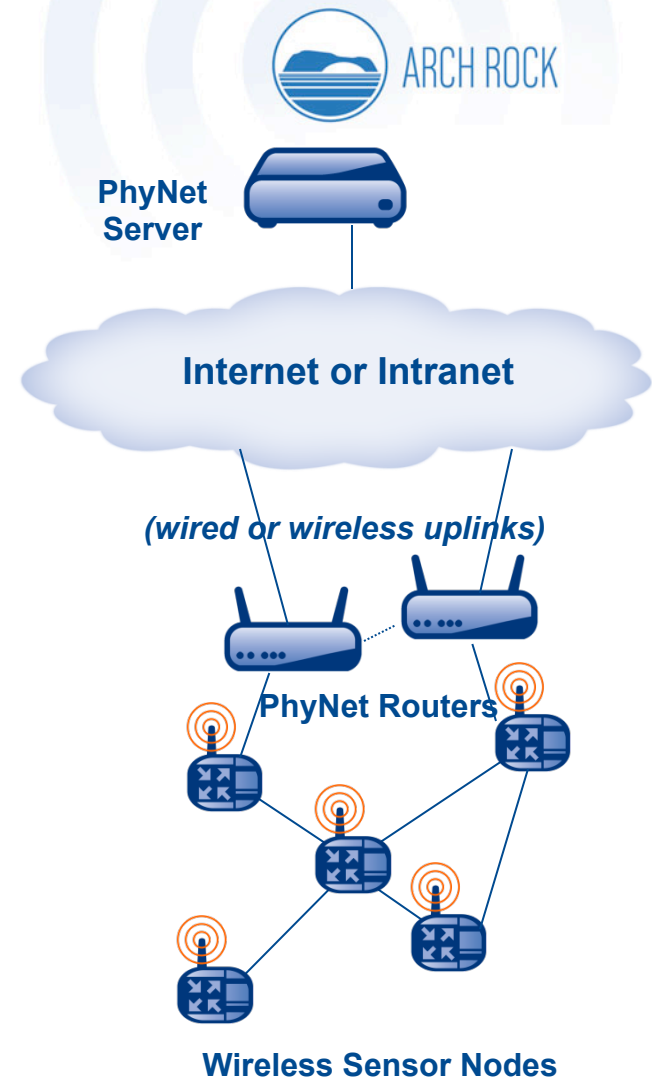
- Network of small-footprint computers
- Optimized for long-life on low power
- Equipped to sense physical data
- Networked using low-power radio

## ➤ 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

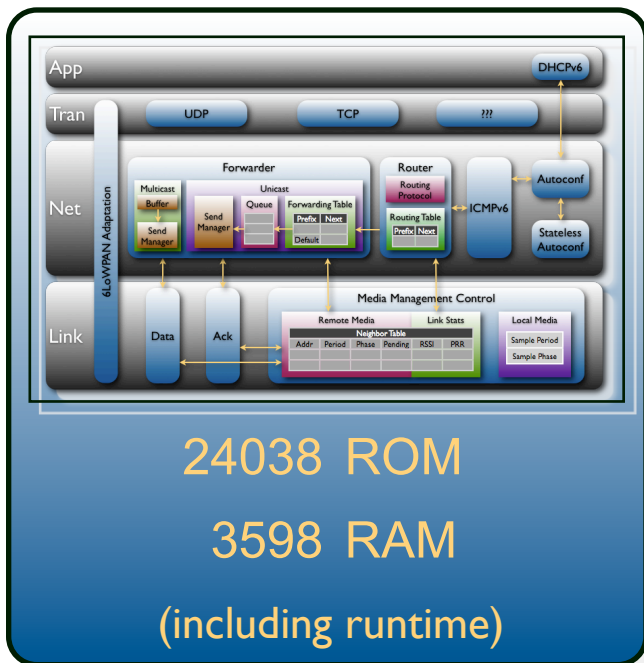
## ➤ Form:

- Node (Processor, Radio, Storage) + Sensors
- Embedded OS, Networking, Applications
- Servers and Routers interfacing with Enterprise IT systems



# Complete Low-Power TCP/IP Stack

## Industry's Smallest Footprint



\* Production implementation on TI msp430/cc2420

- 802.15.4e Low Energy extension
- 100s  $\mu$ W

	ROM	RAM
CC2420 Driver	3149	272
802.15.4 Encryption	1194	101
Media Access Control	330	9
Media Management Control	1348	20
6LoWPAN + IPv6	2550	0
Checksums	134	0
SLAAC	216	32
DHCPv6 Client	212	3
DHCPv6 Proxy	104	2
ICMPv6	522	0
Unicast Forwarder	1158	451
Multicast Forwarder	352	4
Message Buffers	0	2048
Router	2050	106
UDP	450	6
TCP	1674	50



# RFC 4944 - IPv6 Header Compression

## 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

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			





# RFC 4944 Header Compression Examples

## IEEE 802.15.4 header (22 bytes)

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

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

<b>DSP</b>	<b>HC1</b>	<b>HC2</b>	<b>Hop Limit</b>	<b>UDP ports</b>	<b>UDP Cksm</b>
------------	------------	------------	----------------------	----------------------	---------------------

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

<b>DSP</b>	<b>HC1</b>	<b>HC2</b>	<b>Hop Limit</b>	<b>Destination address (FF02::1)</b>	<b>UDP ports</b>	<b>UDP Cksm</b>
------------	------------	------------	----------------------	--	----------------------	---------------------

## Compressed IPv6/UDP header (31 bytes)

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

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



# Enhanced 6LoWPAN Header Compression Examples

## IEEE 802.15.4 header (22 bytes)

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

## Compressed IPv6/UDP header (6 bytes) FE80::0217:3B00:1111:2222 -> FE80::0217:3B00:3333:4444

<b>IPHC</b>	<b>NHC</b>	<b>UDP ports</b>	<b>UDP Cksm</b>
-------------	------------	----------------------	---------------------

## Compressed IPv6/UDP header (7 bytes) FE80::0217:3B00:1111:2222 -> FF02::1

<b>IPHC</b>	<b>Mcast Group</b>	<b>NHC</b>	<b>UDP ports</b>	<b>UDP Cksm</b>
-------------	------------------------	------------	----------------------	---------------------

## Compressed IPv6/UDP header (9-10 bytes)

<b>IPHC</b>	<b>CID</b>	<b>Hop Limit</b>	<b>Destination IID (0068)</b>	<b>NHC</b>	<b>UDP ports</b>	<b>UDP Cksm</b>
-------------	------------	----------------------	-----------------------------------	------------	----------------------	---------------------

2001:0db8:cafe:cafe:0217:3B00:1111:2222 -> 2001:0db8:beef:beef: :68

# IP WSN Eco-System



Solutions

Arch Rock Energy Optimizer (AREO)

Building

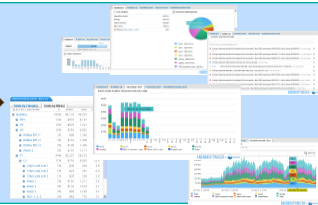
Data Center

Wiring Closet

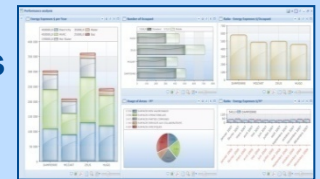
Eco-System Partners  
Environmental

Municipal streets,  
High-end agriculture

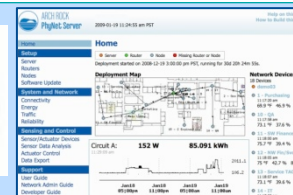
Applications



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



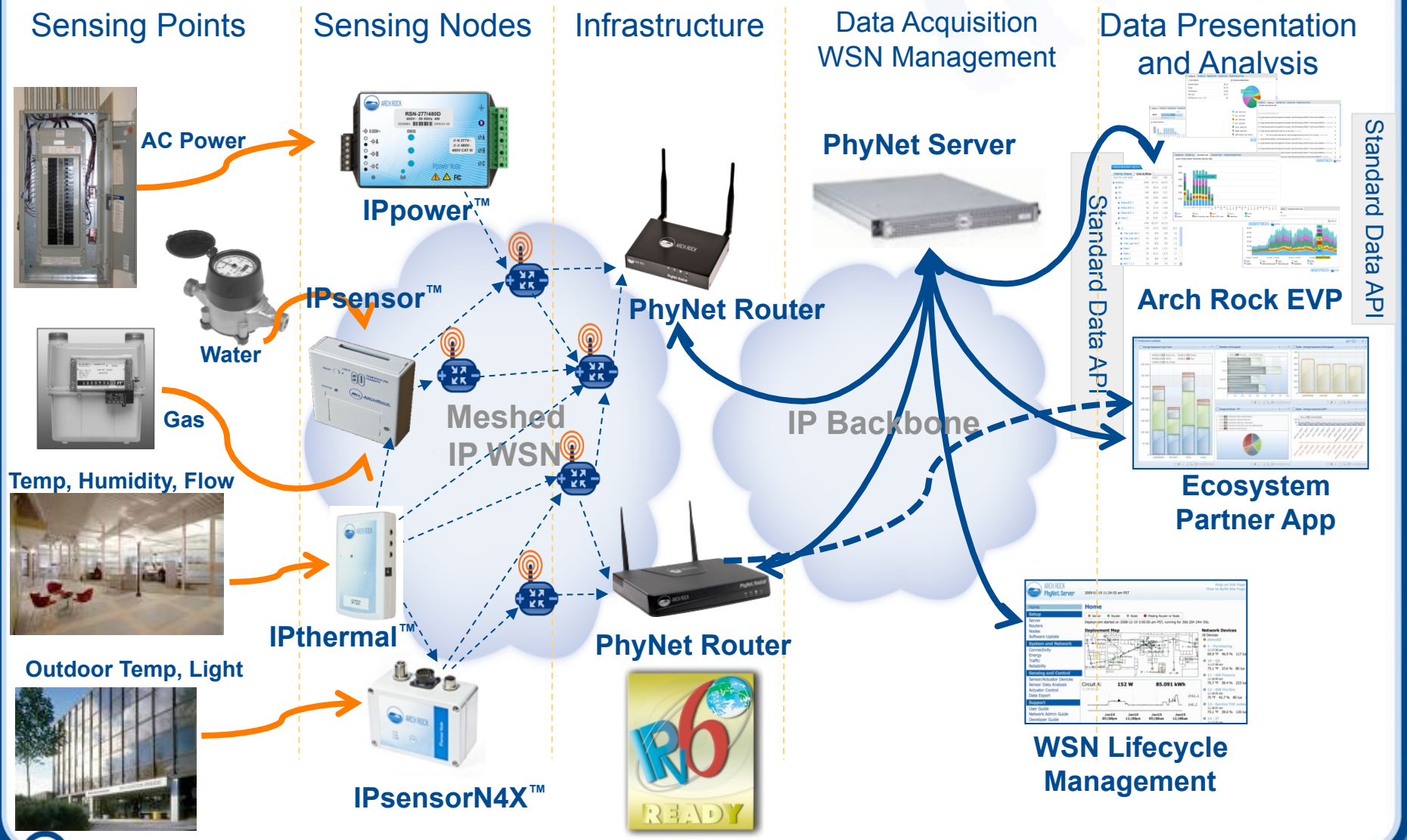


# Key Drivers of Fine-Grained and Real-Time Energy Visibility

- 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, EPA Act 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*



# AR Energy Optimizer Architecture

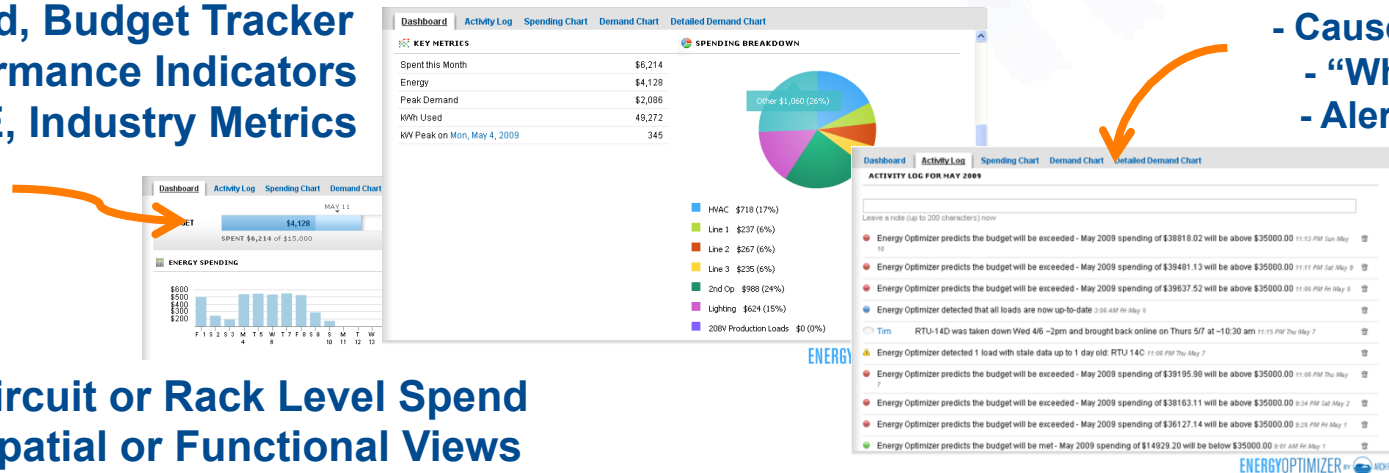


# Arch Rock Energy Optimizer



- Dashboard, Budget Tracker
- Key Performance Indicators
- PUE, DCiE, Industry Metrics

- Activity Log
- Cause/Effect
- "What If"
- Alert Trail

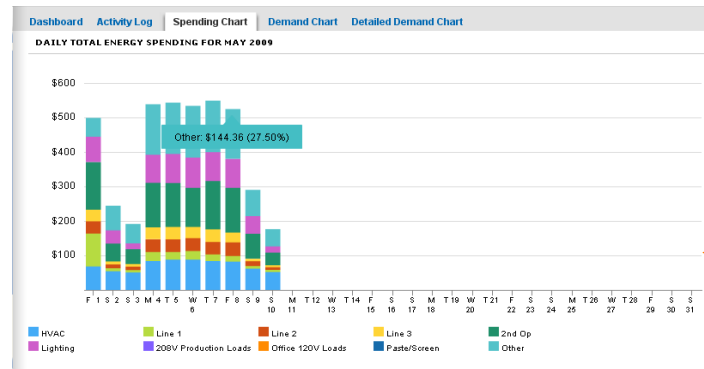


- Circuit or Rack Level Spend
- Spatial or Functional Views

WHOLE BUILDING: \$6,214

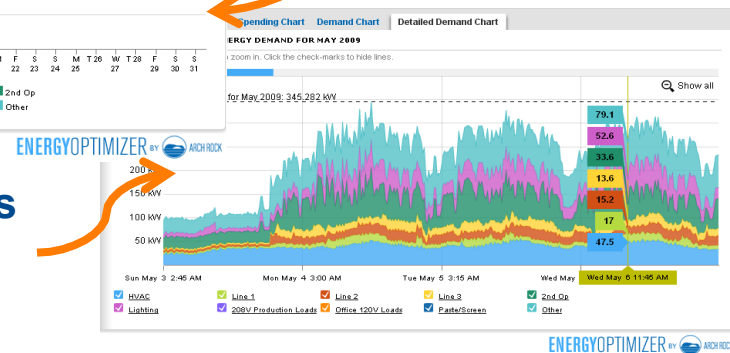
Totals by Category

ELECTRIC LOAD NAME	%	SPENT	KWH	KWH NOW
Building	100%	\$4,132	49,323	149.6
RP1	12%	\$516	6,197	17.3
H2	15%	\$625	7,321	20.3
H3	18%	\$764	9,082	43.8
Reflow BTU 1	2%	\$99	1,356	1.7
Reflow BTU 2	3%	\$110	1,306	8.1
Reflow BTU 3	3%	\$109	1,306	8.5
Wash 2	2%	\$101	1,171	0.0
T1	54%	\$2,227	26,723	68.3
L3	17%	\$716	8,583	23.8
Chip Load Juki 1	1%	\$36	430	2.6
Chip Load Juki 2	1%	\$24	281	0.0
Chip Load Juki 3	1%	\$28	336	2.4
Wave 1	2%	\$101	1,211	3.4
Wave 2	3%	\$133	1,610	3.7
Wave 3	2%	\$98	1,160	3.4
5DX: 1, 2, 3	2%	\$64	776	3.1

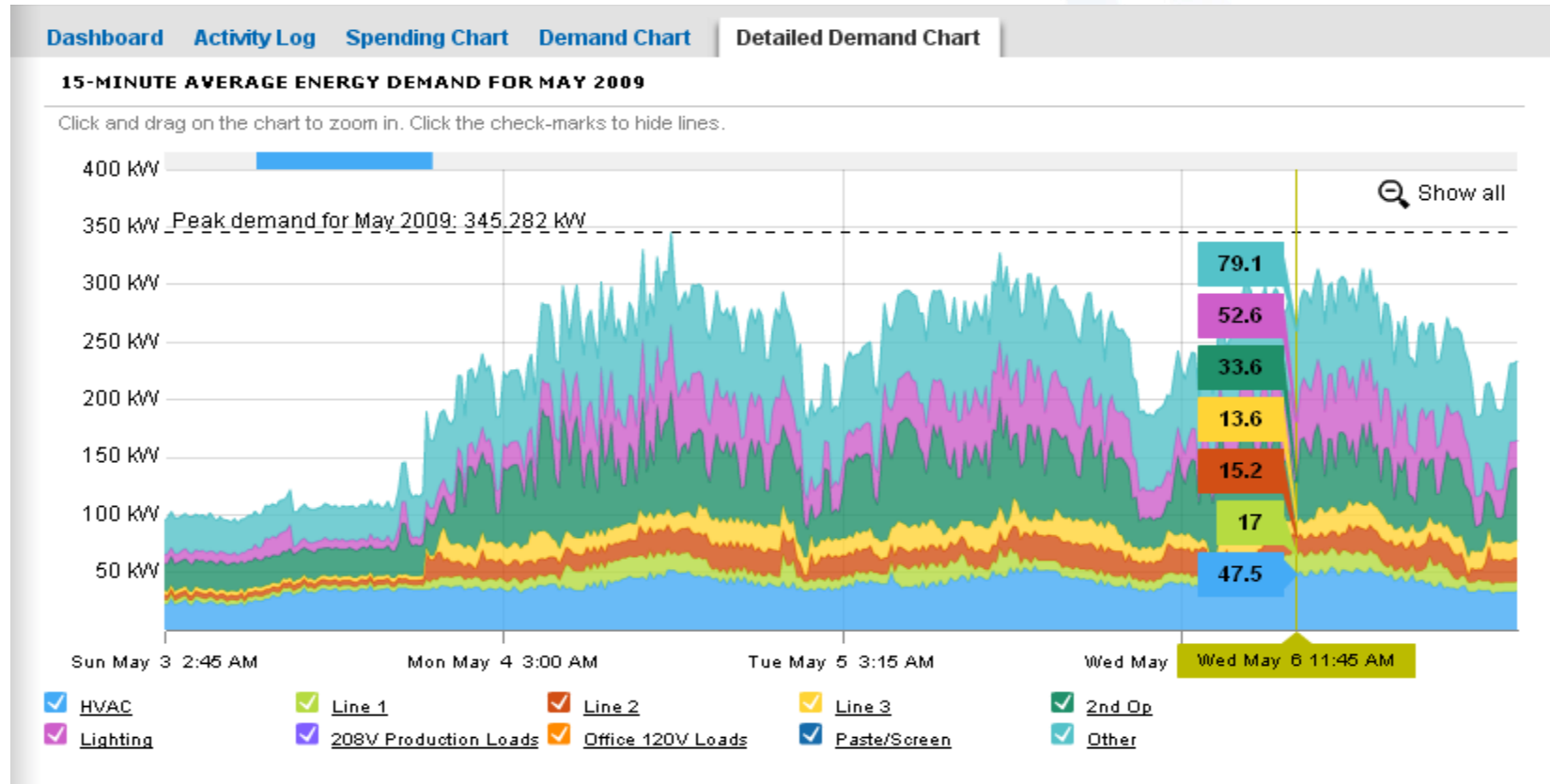


- Daily \$ Spent
- Utility \$ Rate
- kW versus \$

- Real-Time Energy Views
- Itemized Load Profiles
- Impact Analysis



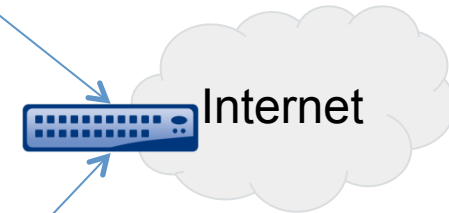
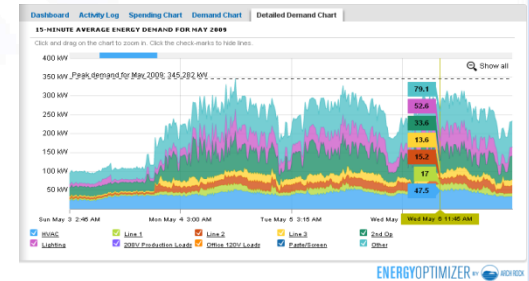
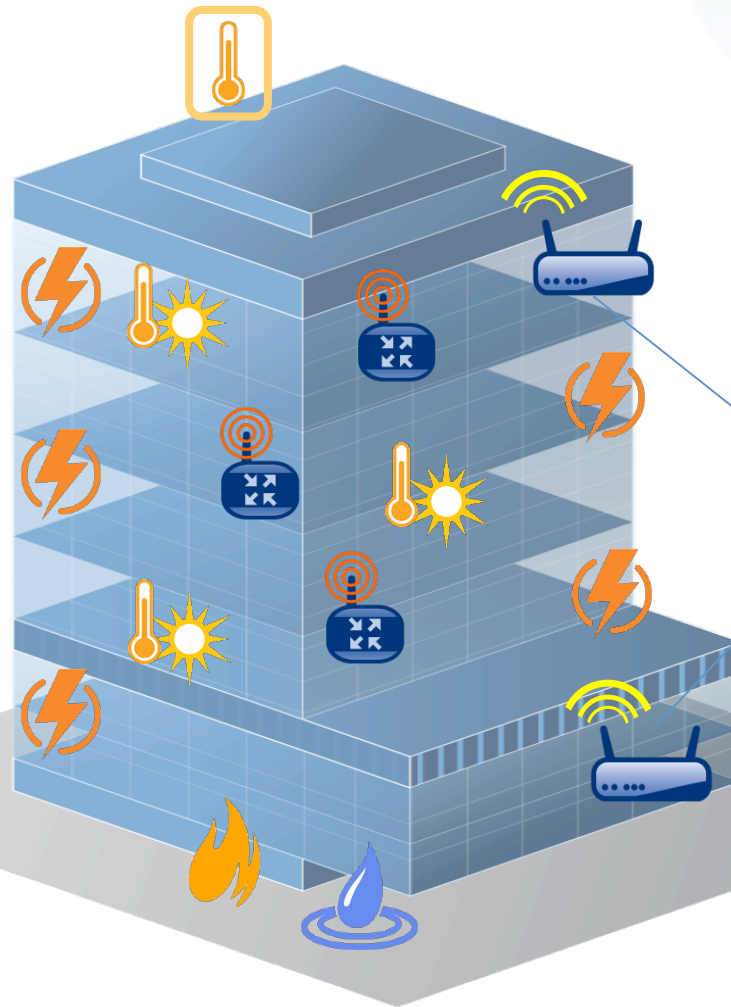
# AREO Energy Monitoring









ENERGYOPTIMIZER BY ARCH ROCK

- Energy Real-Time monitoring chart

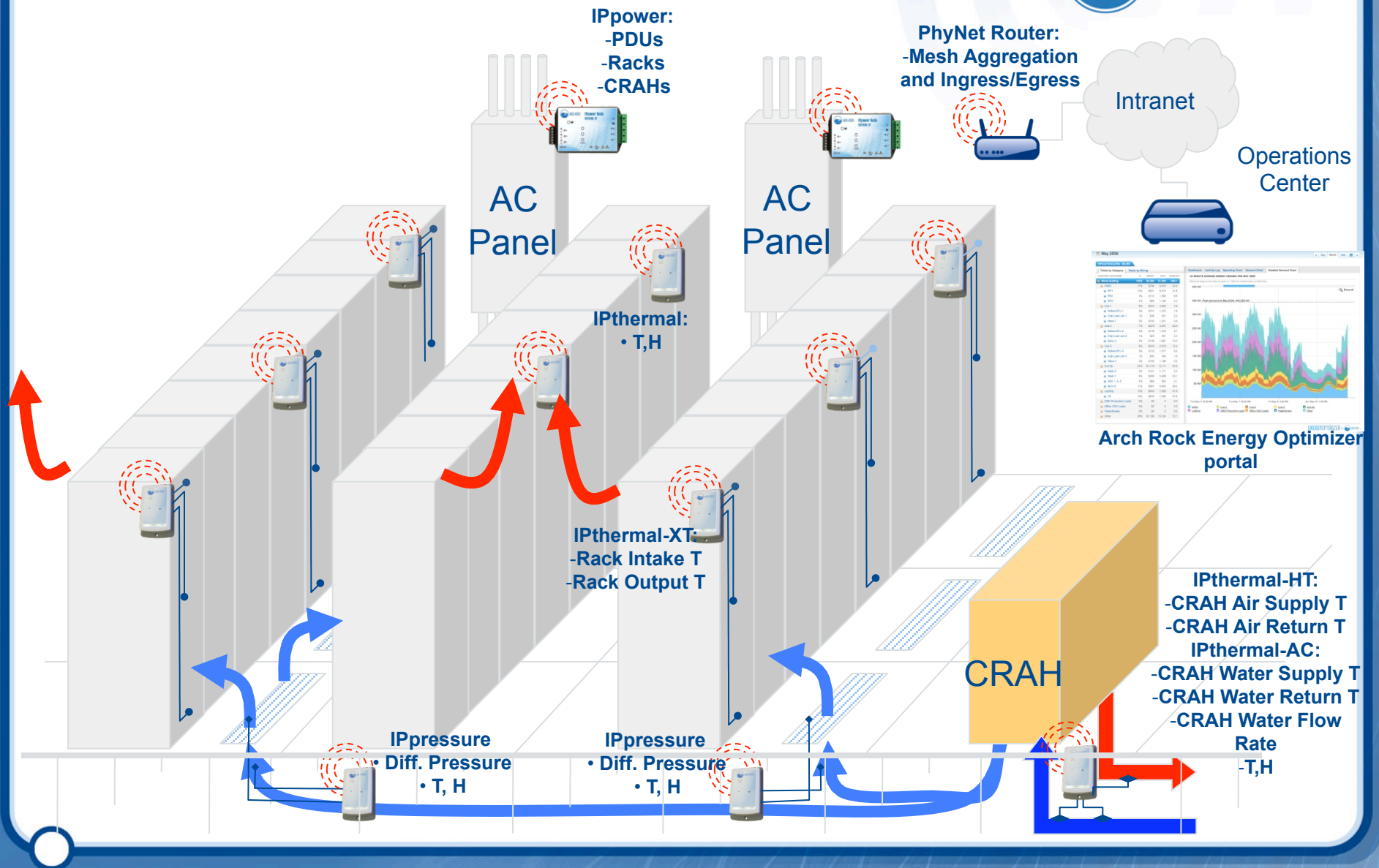
# AREO in Building-wide Facilities



-  AC power submeters  
IPpower nodes
-  Gas/Water submeters  
IPsensor nodes
-  Temp, Hum., Light  
IPsensor nodes
-  Outdoor Temp  
IPsensorN4X
-  IPrelay nodes
-  Routers



# AREO in the Data Center



# IP WSN in Municipal Streets Services

- 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



# IP WSN in High-end Agriculture

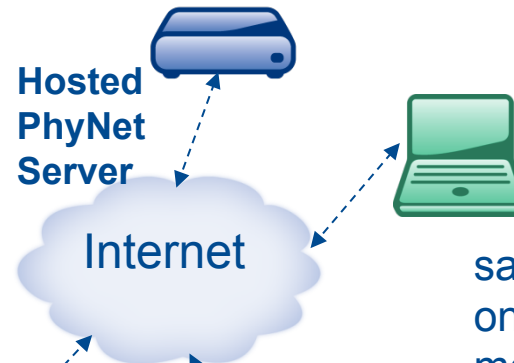


<http://www.networkworld.com/newsletters/wireless/2009/030209wireless2.html>

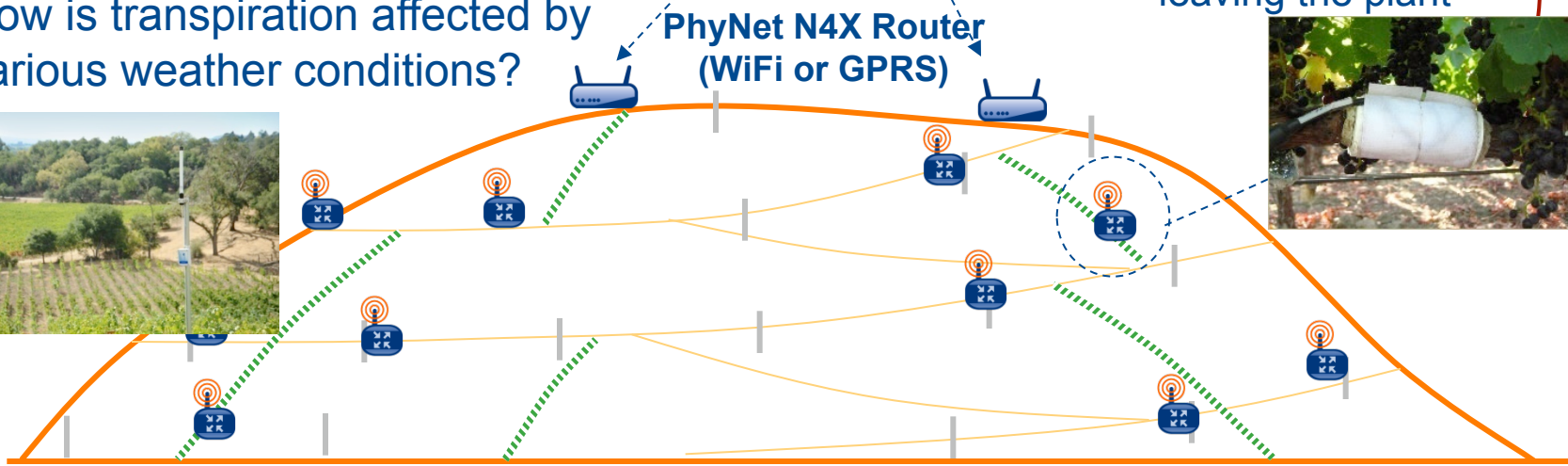
**Winery fine-tuning of irrigation process, grow quality grapes**

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

How is transpiration affected by various weather conditions?



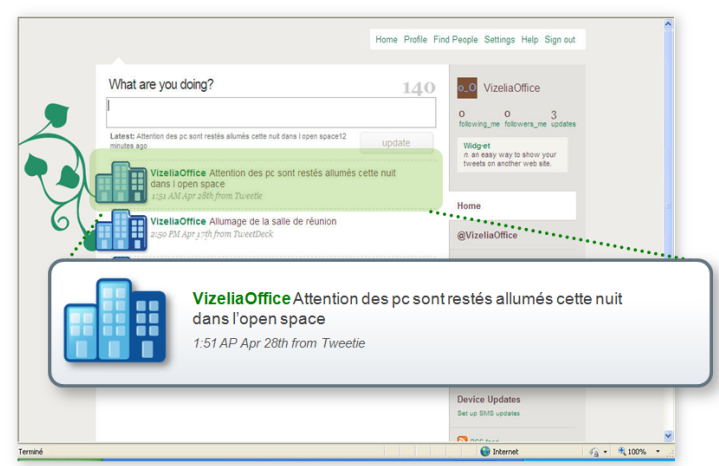
sap-flow sensors on IPserial nodes measuring the amount of water leaving the plant





# 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](http://ec.europa.eu/information_society/policy/rfid/documents/c_archrock.pdf)





## Take Away

- IP infrastructures are in place
  - Services, management, routing
- Nodes may have to store data, then forward when network is available
  - Not different from known applications such as e-mails
- Scaling access to data
  - Node vs server level
- Analysis of data is really what adds value

# References

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

