Spaghetti and Christmas Lights or Networking Your Shelter

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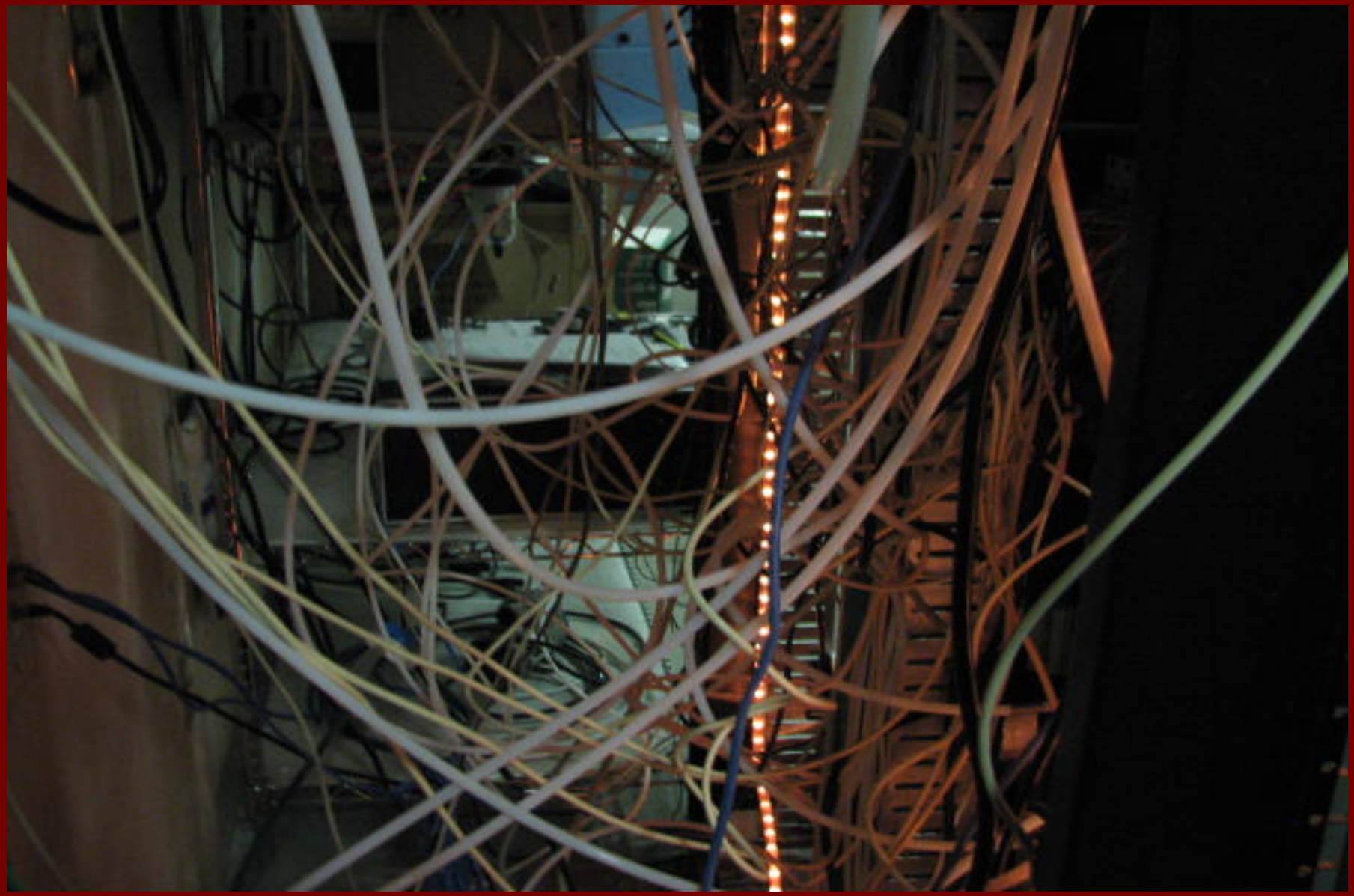
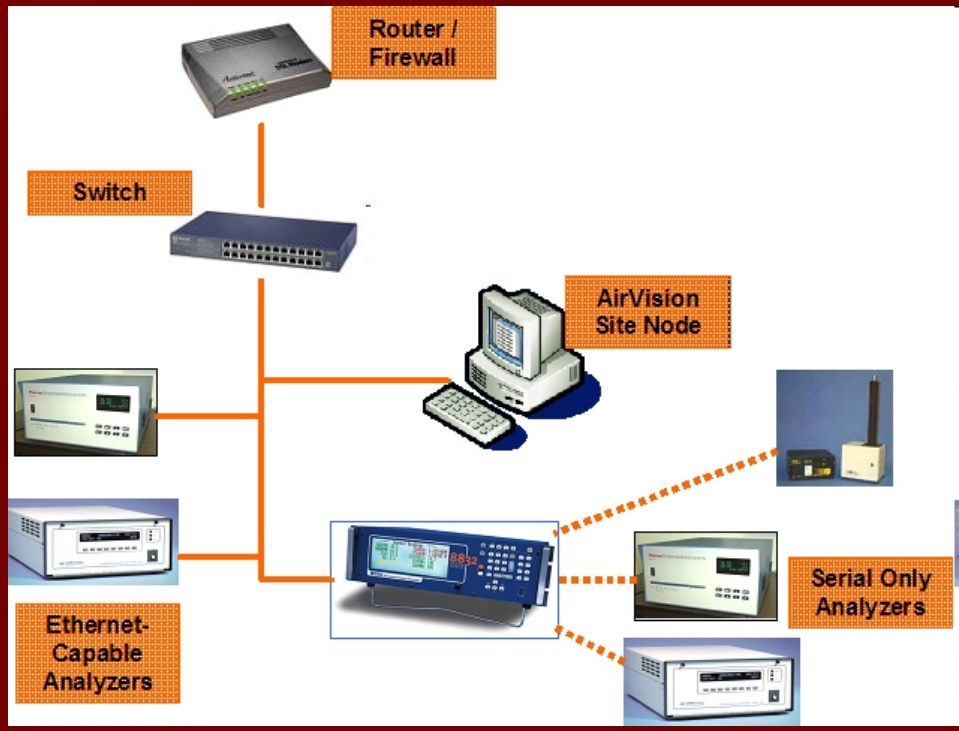
Spaghetti and Christmas Lights



Typical Shelter Hardware Components

- Data Acquisition Front End
  - Data Logger or PC
- Internet Access Device
  - Wireless IP Modem
  - DSL / Cable Modem
  - Satellite
- Router
  - May be built into Internet Device
- Analyzers and Samplers
  - New analyzers are Ethernet-capable now
  - Most are still serial, but *terminal servers* can be used to connect them to a network or a logger

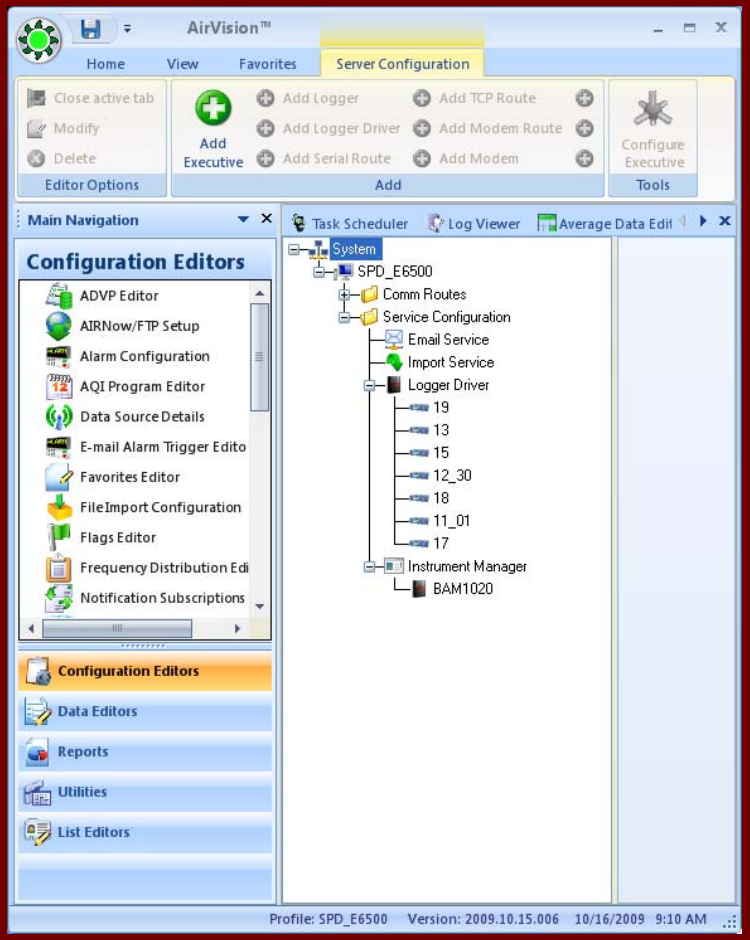


Software Components

- **Data Acquisition Software**
  - **Connections within the shelter**
    - **Logger to analyzer**
  - **External from the main DAS server**
    - **Central DAS to logger**
    - **Central DAS to analyzer**
- **Diagnostic / Remote Control Software**
    - **Any client PC to analyzer**
- **Specialty Software**
  - **e.g., Download sampler data**

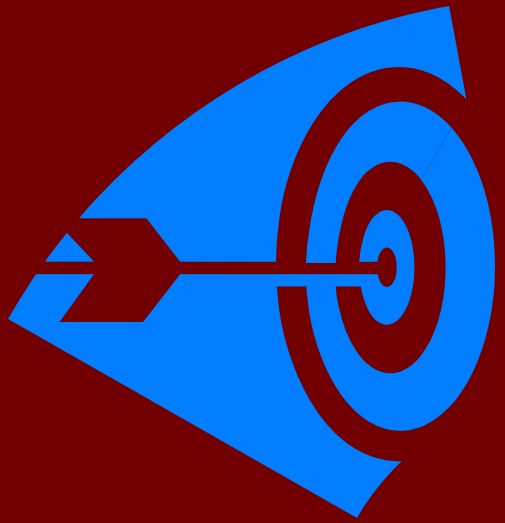
Note that in a networked environment, the location isn't important to the software

But how do we make the most of all of these options and components?



Define Goals

- To have a Digital DAS with Analog Backup
  - Proposed NCore Requirements
  - Better data
- To have remote Trouble-shooting capability
  - Collect Continuous Diagnostic Values
  - Or on demand only when there is a problem
- To eliminate the need for manual downloading of data (e.g. Hyperterminal for BAMs)
- BAM data shift
- To see what AirVision can do
  - It’s not only an upgrade, but also a new product

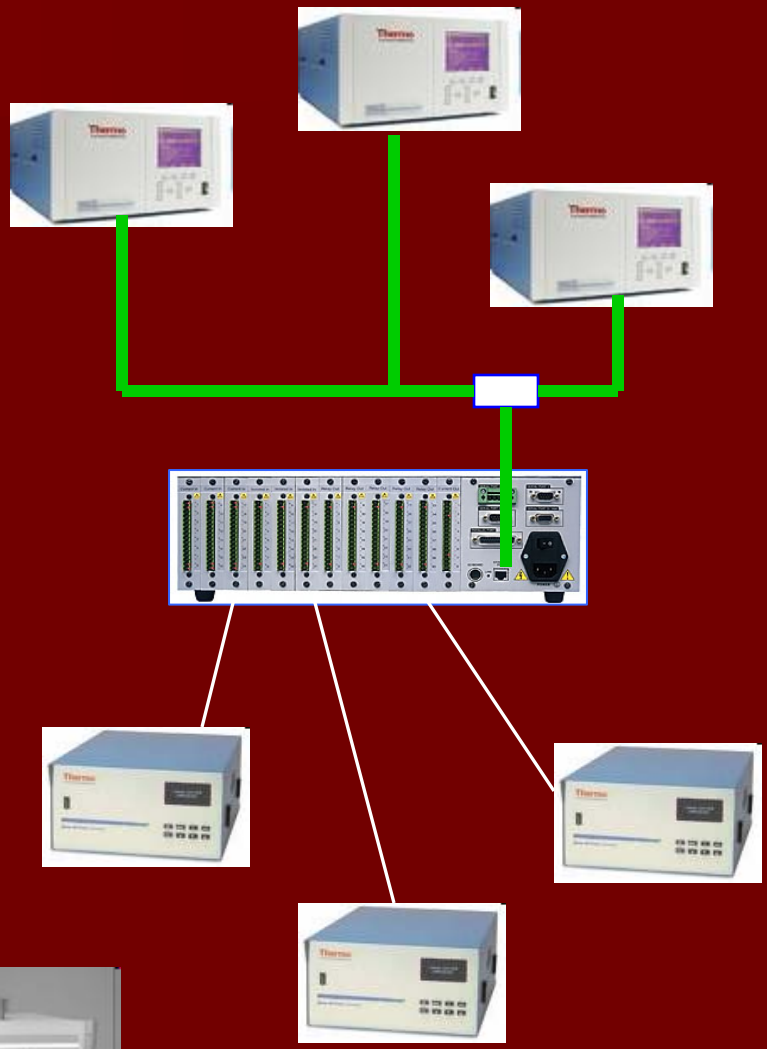


Our Architecture

- **Our Analyzers:**
  - 2 Model 8832 data loggers
  - 2 collocated 49i Ozone
  - 1 43i-TLE SO2
  - 1 48i-TLE CO
  - 142i NOx
  - 2 collocated PM2.5 TEOM FDMSs
  - 2 collocated PM2.5 BAM-1020
  - Meterological Station: Wind Speed, Wind Direction, Relative Humidity, Ambient Temperature
- **Site is polled over private LAN connection inside the firewall.**
- **All analyzer connections were retained as analog**

Our Data Acquisition System

- We had a 'digital' PC logger we were testing with RS-232 connections.
  - Problems:
    - Internal network updates-data lost
    - Clock Sync Issues-BAMs
    - Could not perform auto-cals with multiple calibrators
- Our analog data system was through Agilaire. We wanted to know what they could offer us for a digital connection.
- We are not network experts and needed help in moving everything over to digital
- Agilaire wanted another beta test site for their new AirVision software, so a deal was struck for Agilaire to come on-site and help us connect everything at our multi-pollutant site.



Our Discoveries

- The BAM could be directly polled by AirVision via a terminal server.
- All Thermo i-series analyzers had ethernet capabilities
- To compensate for a lack of Ethernet ports, a switch can be added to connect multi Ethernet cables from the 8832 data logger and Ethernet-capable analyzers.
- Now the fun part- setting up communications!

LAN

Shelter Switch

Introduction to Ethernet/Modbus

- **Modbus over Ethernet was the ideal choice for the digital communications:**
  - **Transmission is error checked**
  - **Standardized protocol**
  - **Much faster than RS-232**
  - **Easier to troubleshoot with diagnostic tools built into the 8832 data logger**

- **Modbus only requires that the data logger knows the following:**
  - **Analyzer IP**
    - *we set*
  - **Analyzer port**
    - *defined by manufacturer*
  - **Register # in analyzer**
    - *from analyzer manual*
  - **What destination channel/parameter in the 8832 / AirVision**
    - ***we choose***

Table C-1. Read Coils for 49*i*, continued

Coil Number	Status
23	CONC ALARM
24	MB STATUS ALARM
25	INTERFACE BD STATUS ALARM
26	I/O EXP BD STATUS ALARM
27	AUTORANGE
28	SERVICE

Table C-2. Read Registers for 49*i*

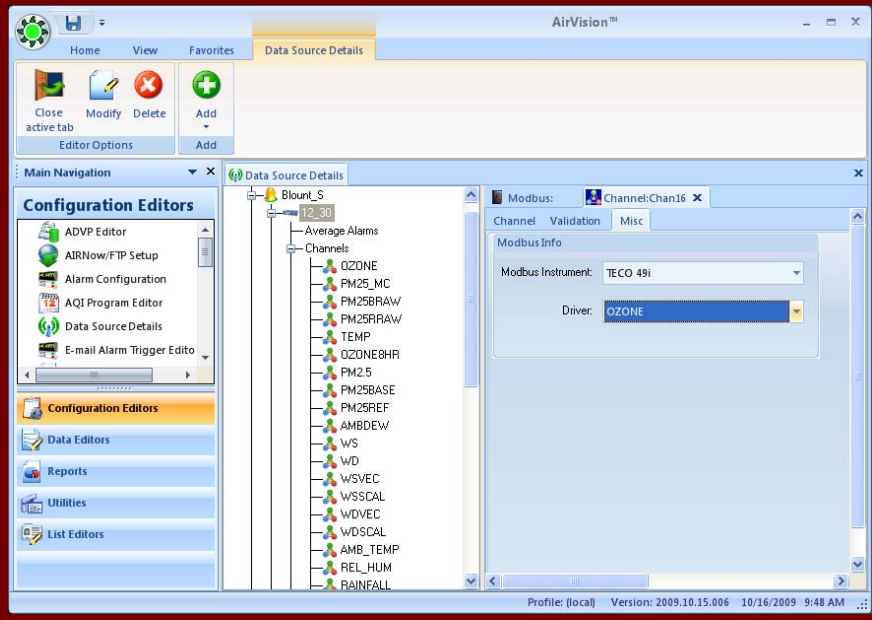
Register Number	Variable
40001&40002	O_3
40003&40004	LO O_3
40005&40006	HI O_3
40007&40008	RANGE STATUS
40009&40010	INTENSITY A
40011&40012	INTENSITY B
40013&40014	NOISE A
40015&40016	NOISE B
40017&40018	FLOW A
40019&40020	FLOW B
40021&40022	PRESSURE
40023&40024	BENCH TEMP
40025&40026	LAMP TEMP
40027&40028	O_3 LAMP TEMP
40029&40030	ANALOG IN 1
40031&40032	ANALOG IN 2
40033&40034	ANALOG IN 3
40035&40036	ANALOG IN 4
40037&40038	ANALOG IN 5
40039&40040	ANALOG IN 6
40041&40042	ANALOG IN 7
40043&40044	ANALOG IN 8

Programming

- **Since we were still running E-DAS as our primary system, Agilaire provided an Excel-based tool to create the server control file that managed all this information.**
- **Just select which parameters you want, where you want them, put in the IPs, and the spreadsheet does the rest.**
  - *Aside from FTPing the file*
- **AirVision 1.0.1 will simplify the process, by just allowing you to select the analyzer brand and register you want, and the Modbus control file is automatically downloaded.**

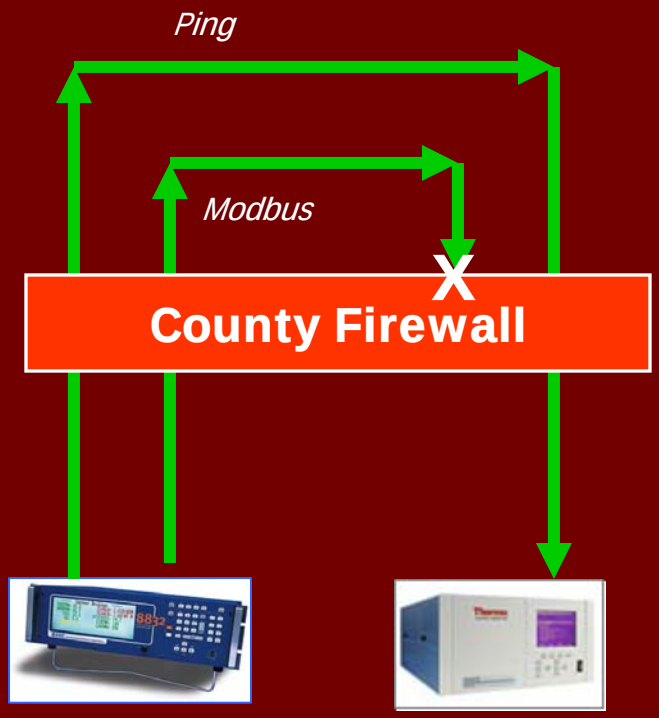
Use this screen to map parameters from your Modbus analyzer to channels on the Model 8832

Analyzer->Logger, Analog (3,16)			(up to 50)	
Analyzer IP	Analyzer Port	Analyzer Register	Logger Channel	Description
192.168.1.42	502	1	9	NO
192.168.1.42	502	3	10	NO2
192.168.1.42	502	5	11	NOX
192.168.1.42	502	35	48	Internal Temp
192.168.1.42	502	37	49	Chamber Temp
192.168.1.42	502	39	50	Cooler Temp
192.168.1.42	502	41	51	Converter Temp
192.168.1.42	502	49	52	Chamber Press
192.168.1.42	502	51	53	Sample Flow
192.168.1.42	502	53	54	PMT Voltage
192.168.1.43	502	1	12	SO2
192.168.1.43	502	21	55	Internal Temp
192.168.1.43	502	23	56	Chamber Temp
192.168.1.43	502	31	57	Chamber Press
192.168.1.43	502	33	58	Sample Flow
192.168.1.43	502	35	59	PMT Voltage
192.168.1.48	502	1	13	CO
192.168.1.48	502	15	60	Internal Temp
192.168.1.48	502	17	61	Bench Temp
192.168.1.48	502	27	62	Sample Flow
192.168.1.48	502	29	63	Lamp Intensity
192.168.1.49	502	1	14	O3
192.168.1.49	502	17	65	FlowA
192.168.1.49	502	19	66	FlowB
192.168.1.49	502	21	67	Pressure
192.168.1.49	502	23	68	Bench Temp
192.168.1.49	502	25	69	Lamp Temp
192.168.1.49	502	27	70	O3 Lamp Temp
192.168.1.49	502	9	71	Lamp Intensity A
192.168.1.49	502	11	72	Lamp Intensity B



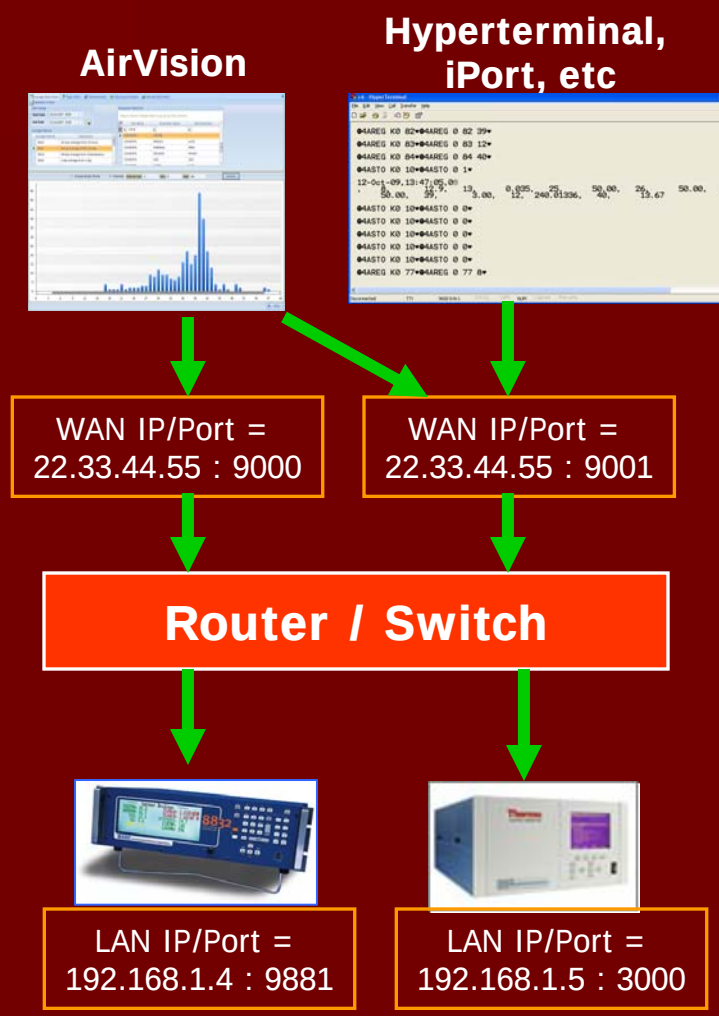
Nothing Ever Goes As Planned

- **Flip the switch, and nothing works (of course)**
- **The data logger could ping the analyzer, but none of the Modbus transactions would go through.**
- **After narrowing it down, we called our IT department** *(remember, this is on an agency LAN?)* **and had the port unblocked.**
- **We ran out of ports on our small switch, so we got a larger one at Office Depot.**
- **In most 'in the shelter networks' you won't have this problem, since you are the network administrator inside your network.**



Things you might need to know for your project

- Our network architecture from Central to Site to site devices is simplified since everything is on the same network.
- Most of you will have access through another gateway device (wireless IP, cable modem, etc).
- You will need to use Network Address Translation or Port Forwarding settings in your router to direct traffic from WAN side ports to LAN side IP/ports
  - We're chemists and scientists, not network experts, so we rely on support from our DAS vendor, Agilaire, to help us with each project, since every shelter network architecture can be unique.



Planning Your Project / Avoiding Pitfalls

- **Your ISP provider or IT blocks ports**
  - ***Address required port ranges as part of the your arrangement with whomever is providing the service***
- **Bad hardware**
  - **Switches, hubs, routers, and even the modems are manufactured based on low cost.**
  - **You can spend days troubleshooting what amounts to a simple hardware problem**
  - **Have 20% spares of the cheap stuff (cables), 10% spares of the more expensive items**
  - **Put all network items on power conditioners / UPS**
- **Diagnostics**
  - **Become familiar with the tools built into the data loggers and analyzers for troubleshooting (ping, any functions to monitor Modbus status)**