

Data Management and Transfer: Telemetry Options

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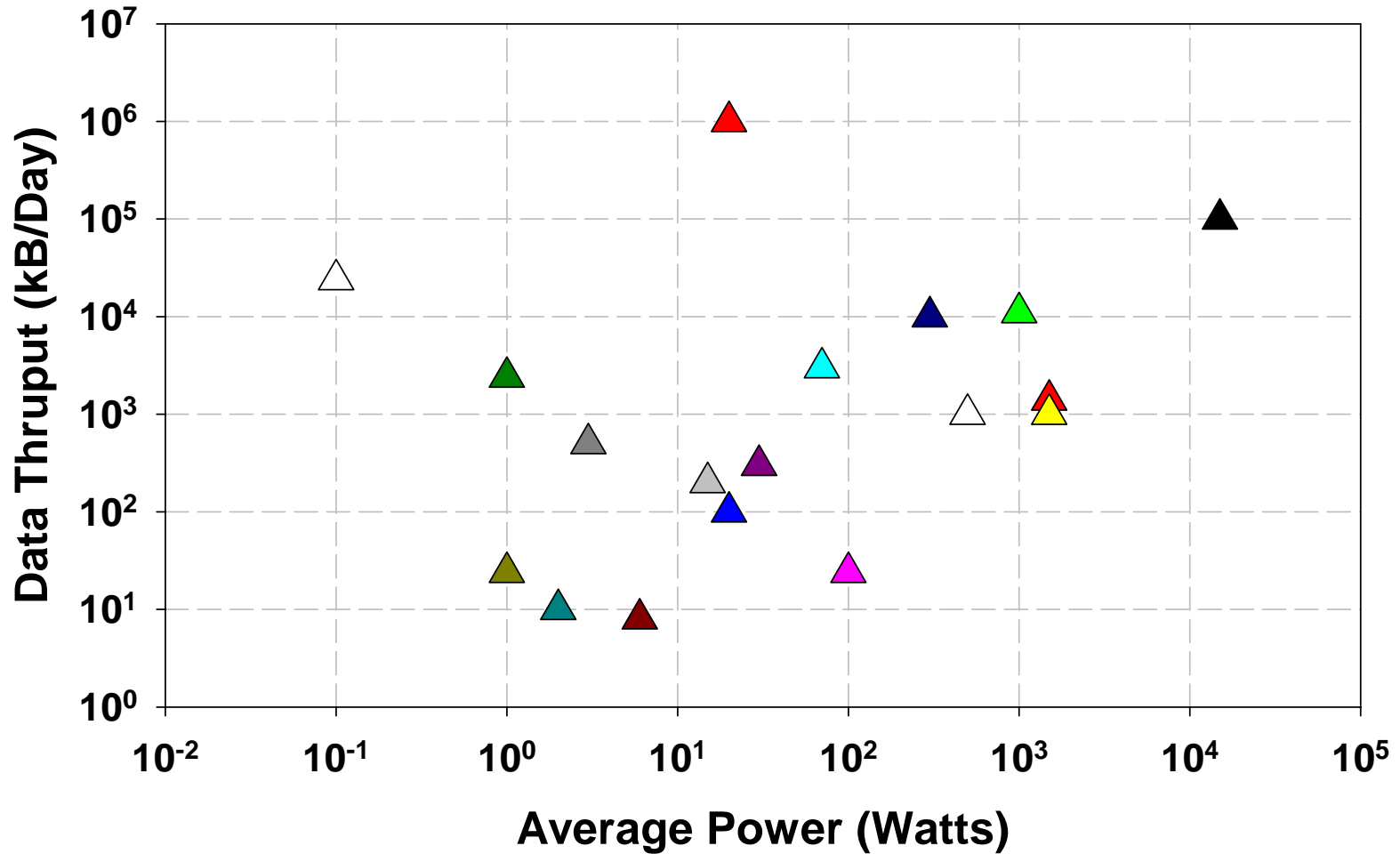
28 January 2004

Presentation Overview

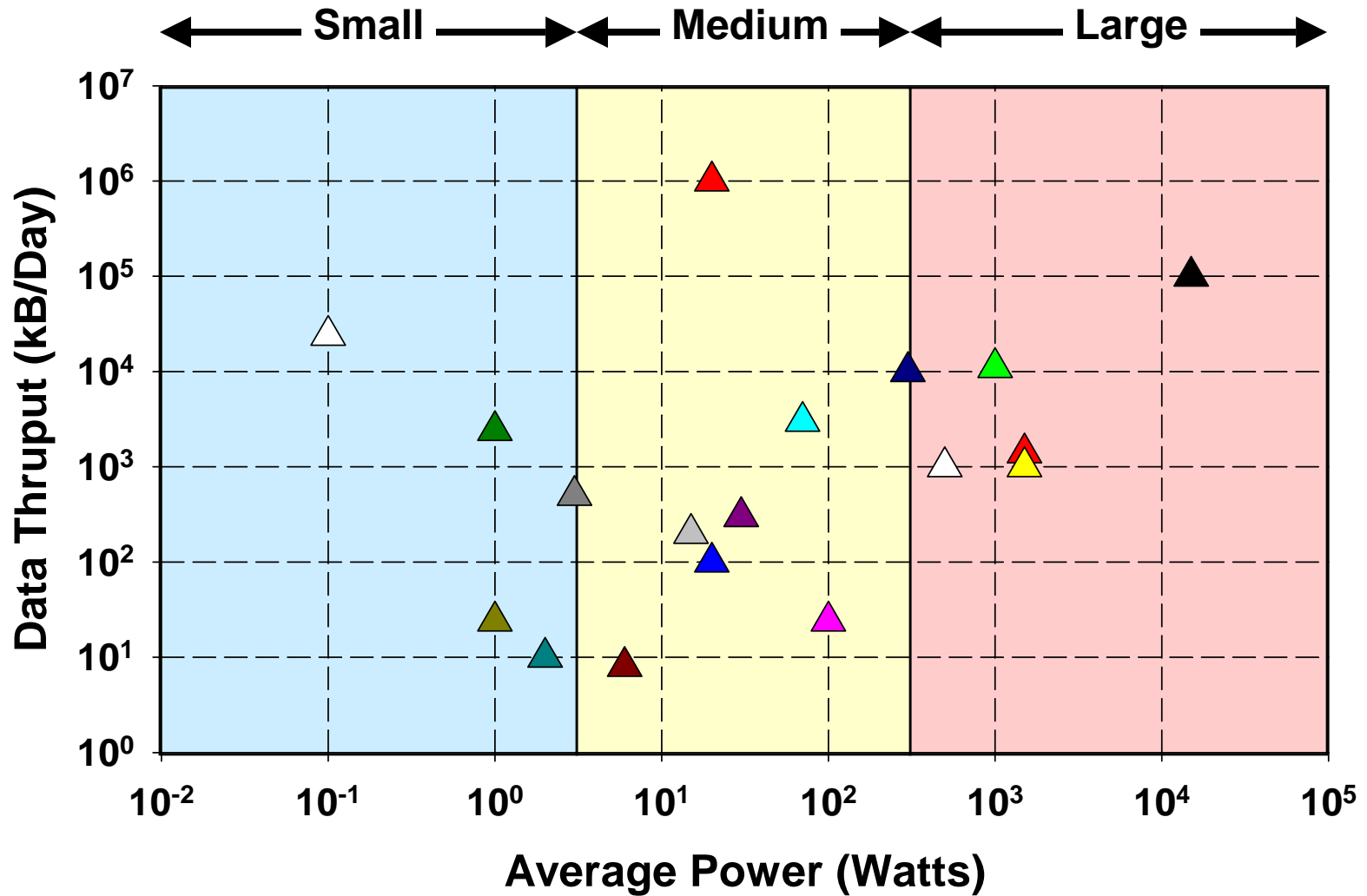
- **Telecommunications Survey Results**
- **System Deployment Categories**
- **Communications Options**
- **Design Tradeoffs**

Data Throughput vs. Average Power

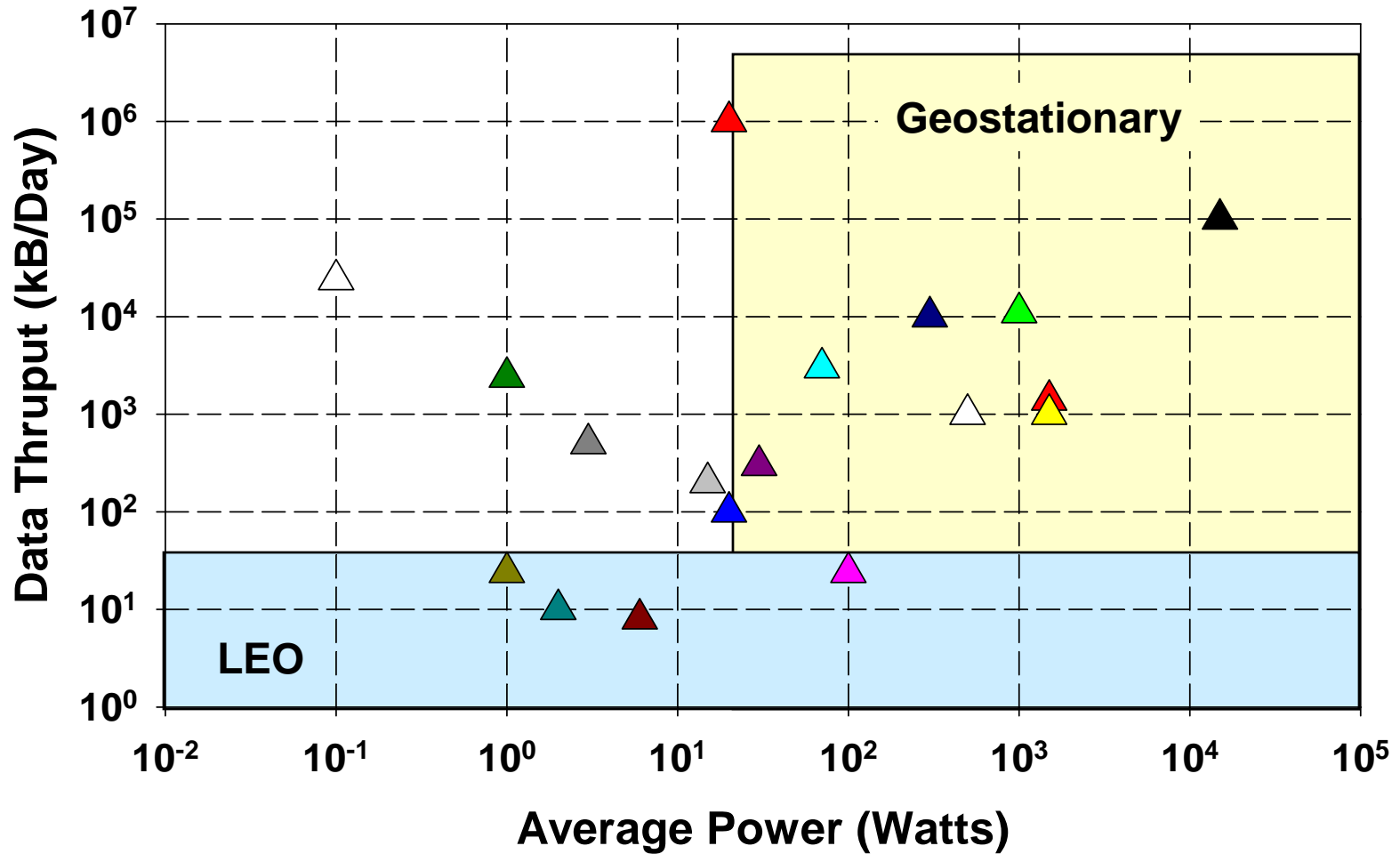
October 2002 Survey Results



Data Throughput vs. Average Power (Power Class)

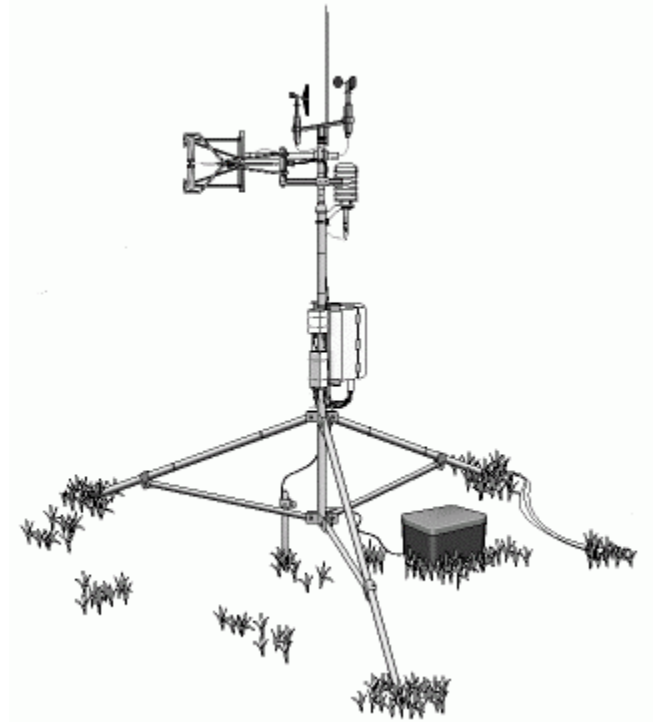


Data Throughput vs. Average Power (Satellite Comms)



Small System

- **Single tower deployment**
- **Battery bank as primary power source**
 - **< 3 Watts average power**
 - **Photovoltaic array or wind turbine as secondary source**
- **Low data throughput requirement**
 - **Daily data & status report**
- **LEO satellite communications service**
 - **Iridium**
 - **Argos**
 - **Orbcomm**
- **Geostationary satellites**
 - **GOES**



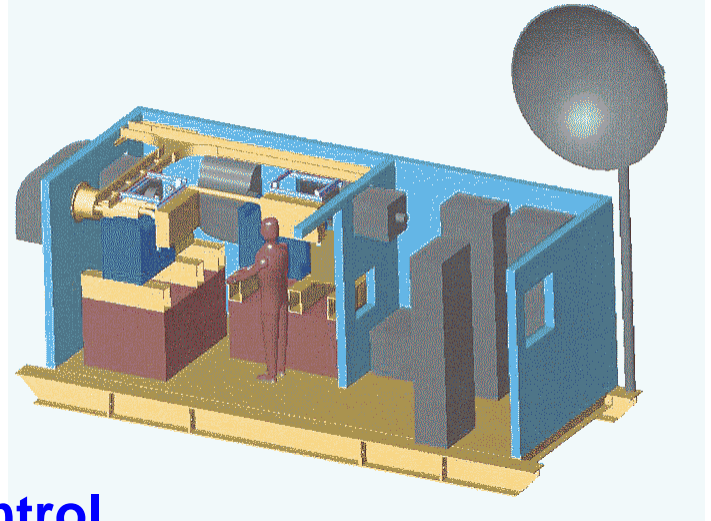
Medium System

- **Generator in shelter**
 - 3 to 300 Watts average power
 - Some thermal management
 - Fuel storage

- **Moderate data throughput**
 - Updates hourly or more often
 - Remote monitoring and system control

- **Geostationary satellite communications system**

- **Need smaller system for easier deployment**
 - **Modular elements to increase capacity**



Large System

- **Permanent Camps**
 - **Summit Camp**
 - **Toolik Lake**
- **> 300 Watts Average Power**
 - **Multiple generator systems**
 - **Major refueling logistics**
- **Large data communications needs**
 - **Data transfers**
 - **E-mail**
 - **Weather**
 - **Logistics planning**
- **Geostationary satellite Internet access**
- **WLAN within camp**



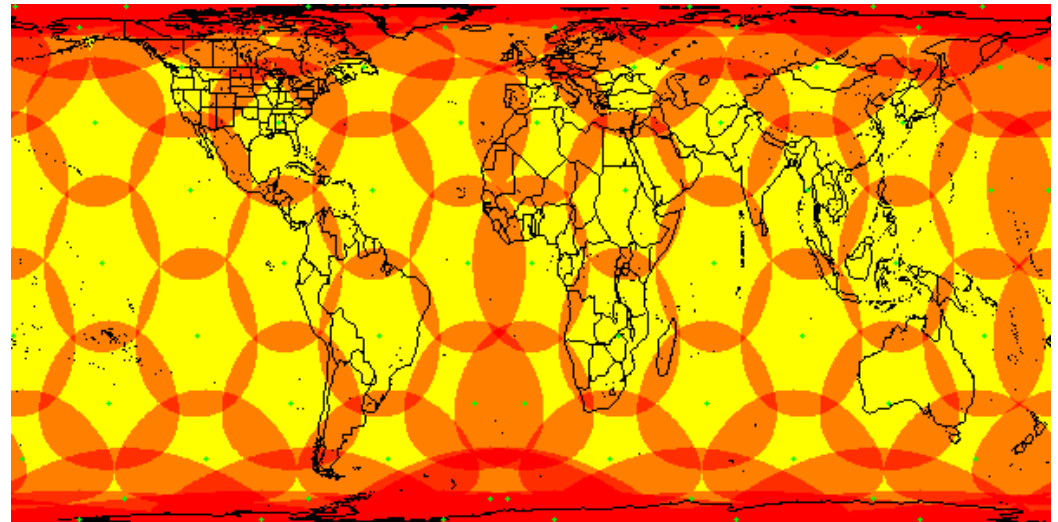
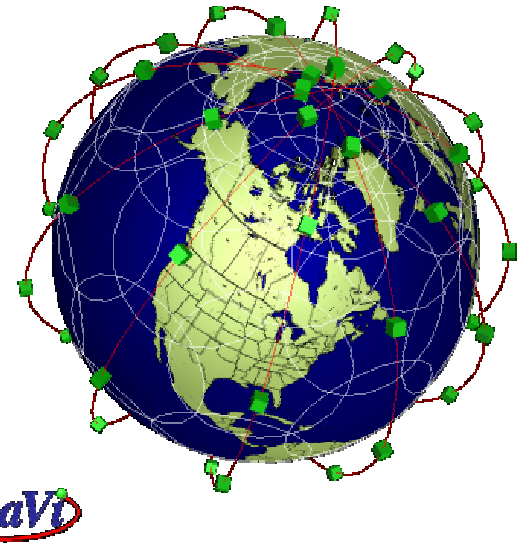
Iridium Satellite Service

- **Low Earth Orbiting (LEO)**
 - 66 active satellites

- **Global coverage**
 - Always in view
 - Concentration at the poles

- **Voice and data**
 - 2400 bps
 - Full duplex

- **Service cost**
 - \$30.60 / month
 - \$1.28 / minute



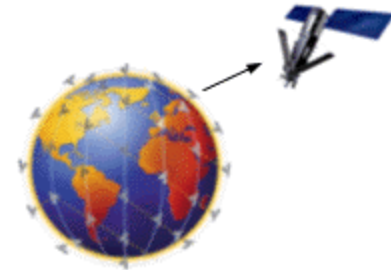
Iridium Satellite Service (cont'd)

- **Rugged (voice and) data transceiver**
 - \$1,200 transceiver
 - \$260 omnidirectional antenna & cable
 - \$150 AC power supply

- **3 Watts transmit power consumption**
 - Datalogger can control power to unit for power conservation

- **Serial data interface to data logger**
 - Simple subset of a Data Transport Network

- **Techniques for enhanced data handling**
 - Bonding for higher data rate
 - DoD unlimited access SIMs

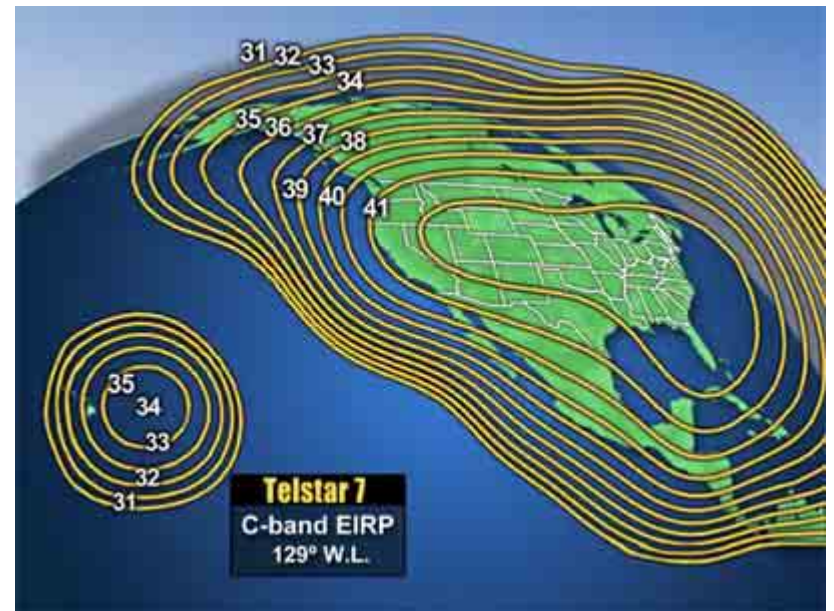


StarBand Satellite Service

- **Geostationary**
 - **Telstar 7 (129° W)**
 - **AMC 4 (101° W)**

- **No service above 72° Latitude**
 - **Large dish required in Alaska**
 - **Low look angles**
 - **Susceptible to icing**

- **High on-demand data rates**
 - **500 kbps downlink**
 - **80 kbps uplink**



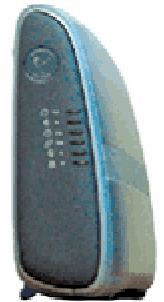
StarBand Satellite Service (cont'd)

- **Commercial service**
 - **\$150 / month (2 year contract)**
 - **Always on service**
 - **500 MB / week upload limit**
 - » 6.6 kbps average limit for “good neighbor”

- **Commercial hardware**
 - **\$600 modem**
 - **\$200 – 1000 dish (1.2 – 1.8 m)**
 - **Certified dish installer required**
 - **0° to +50° C operating range**

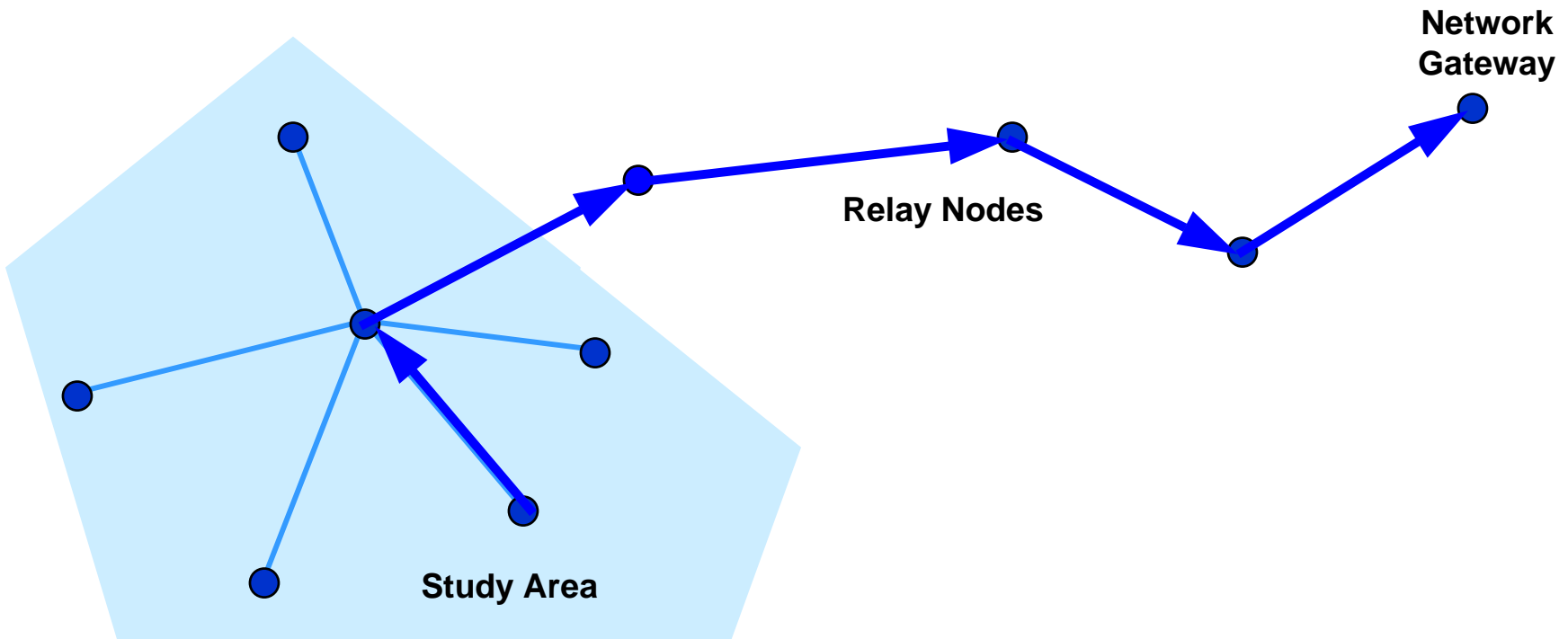
- **Model 360**
 - **Required a PC w/ Windows OS**
 - » Virus and Worm attacks
 - **27 Watts + PC power**

- **Model 480Pro**
 - **Built-in 4-port router**
 - » Controlled communications interface
 - **20 Watts**

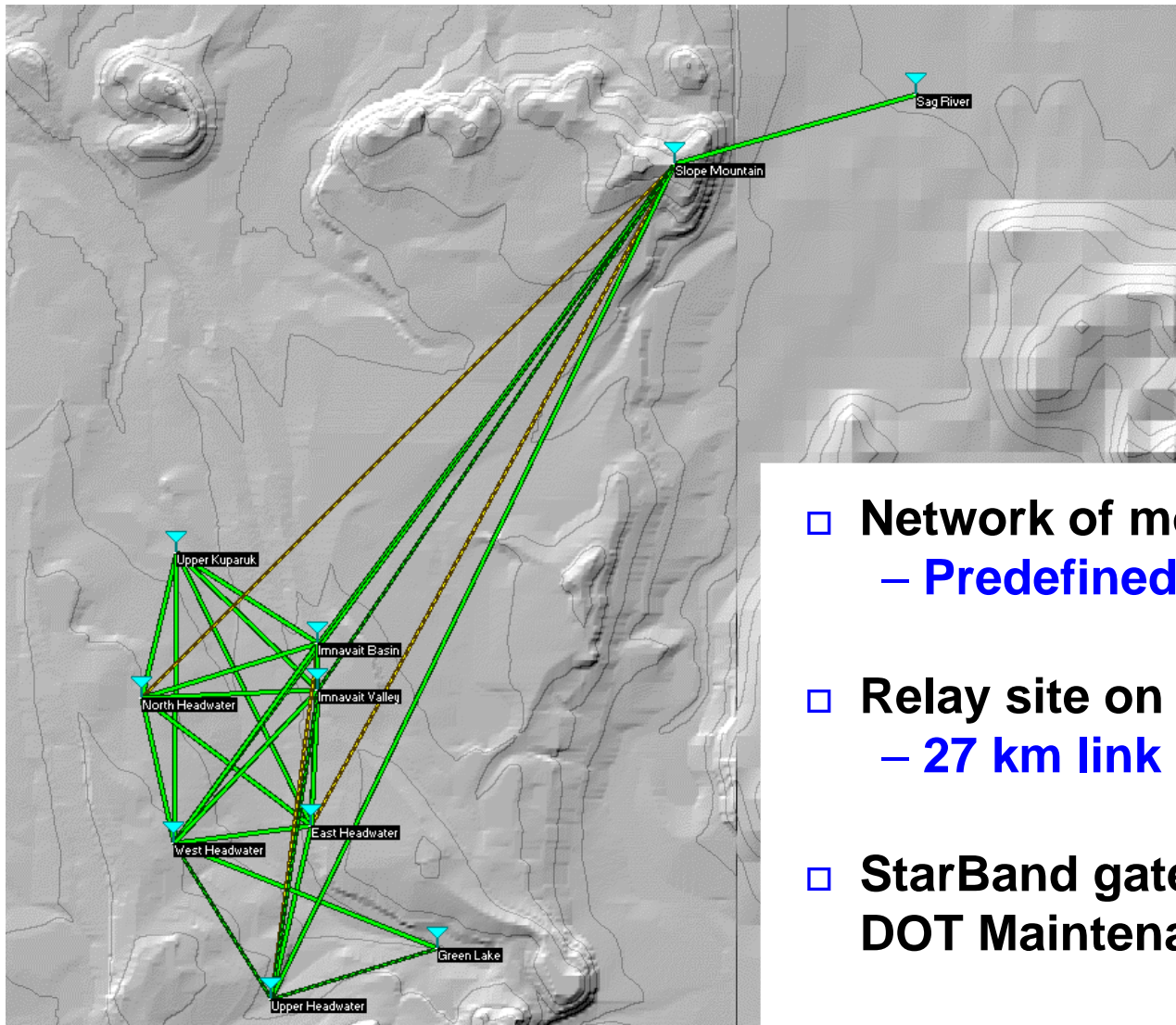


Terrestrial Packet Radio Network

- ❑ Traditional relay network (i.e., packet forwarding)
- ❑ Initial deployment costs
- ❑ Routine maintenance as a recurring cost
- ❑ Star network topology is common



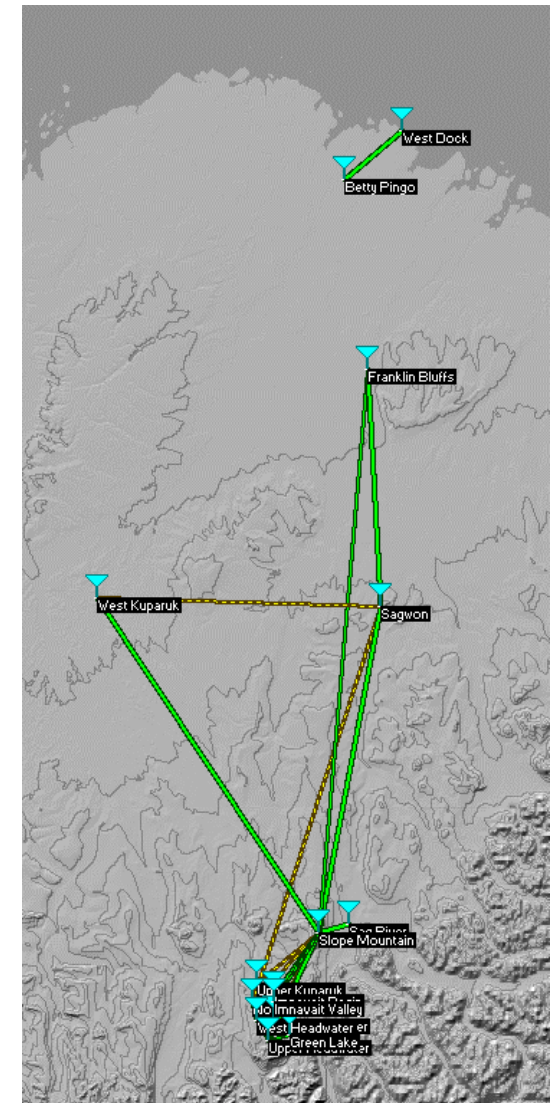
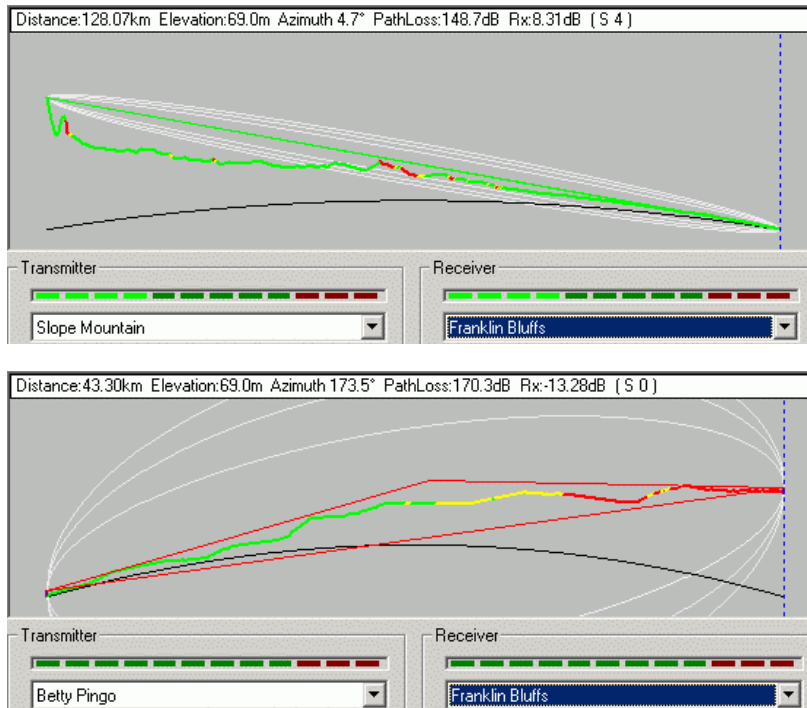
WERC's Upper Kupaak Network



- Network of monitoring stations
 - Predefined relay topology
- Relay site on Slope Mountain
 - 27 km link
- StarBand gateway at Sag River DOT Maintenance Station

Network Topology Extension

- Topography dictates whether links might succeed
- Earth curvature is significant on long links
- Lower frequencies will propagate better
- Range is inversely proportional to data rate



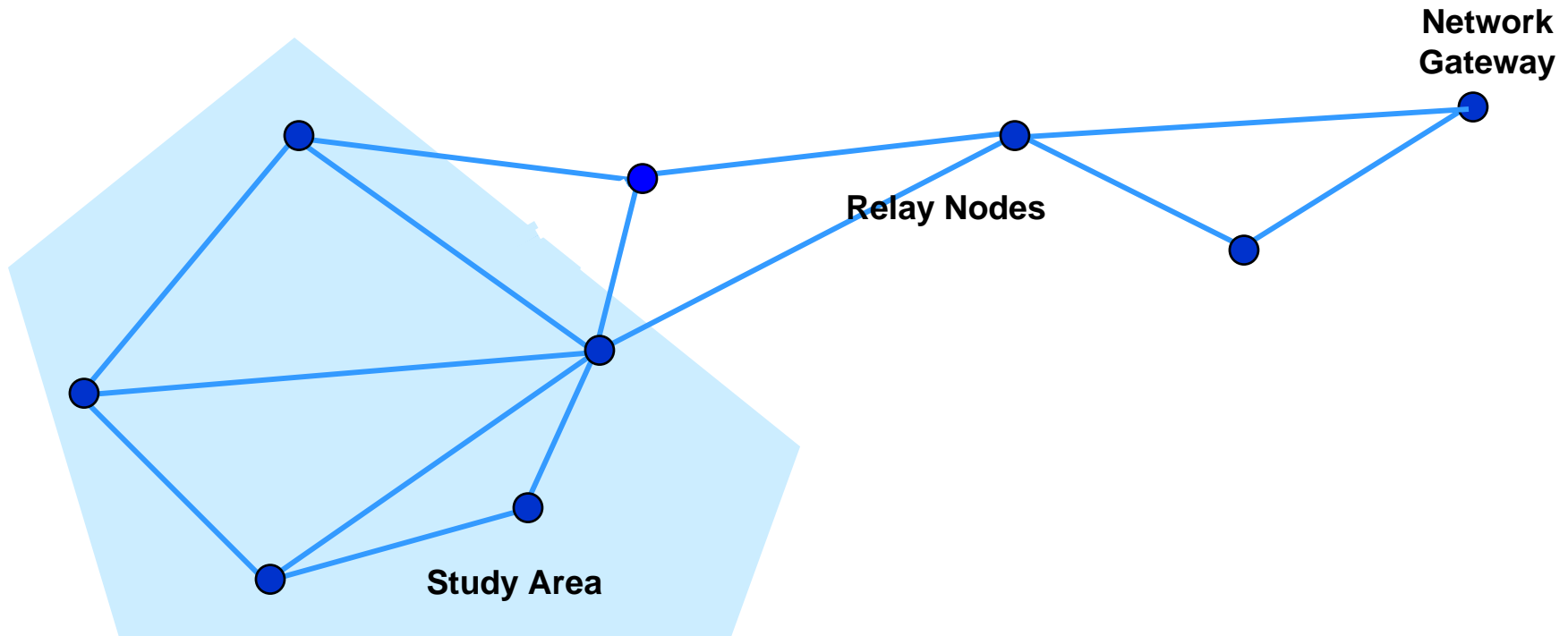
Freewave ISM Band Transceivers

- **ISM Band Spread Spectrum**
 - 902 – 928 MHz
 - 7 hopping bands
- **Data Rate**
 - 38.4 or 115.2 kbps
 - RS-232/422/485 or Ethernet interface
- **Programmable Power Consumption**
 - 0.1 to 1 W transmitter power
 - 6 W maximum while transmitting
 - 72 mW in sleep mode
 - 6 to 30 VDC input range
- **Environmental**
 - Temperature: - 40 to + 75°C
 - Ruggedized
 - Waterproof version
- **Cost**
 - ~ \$1800

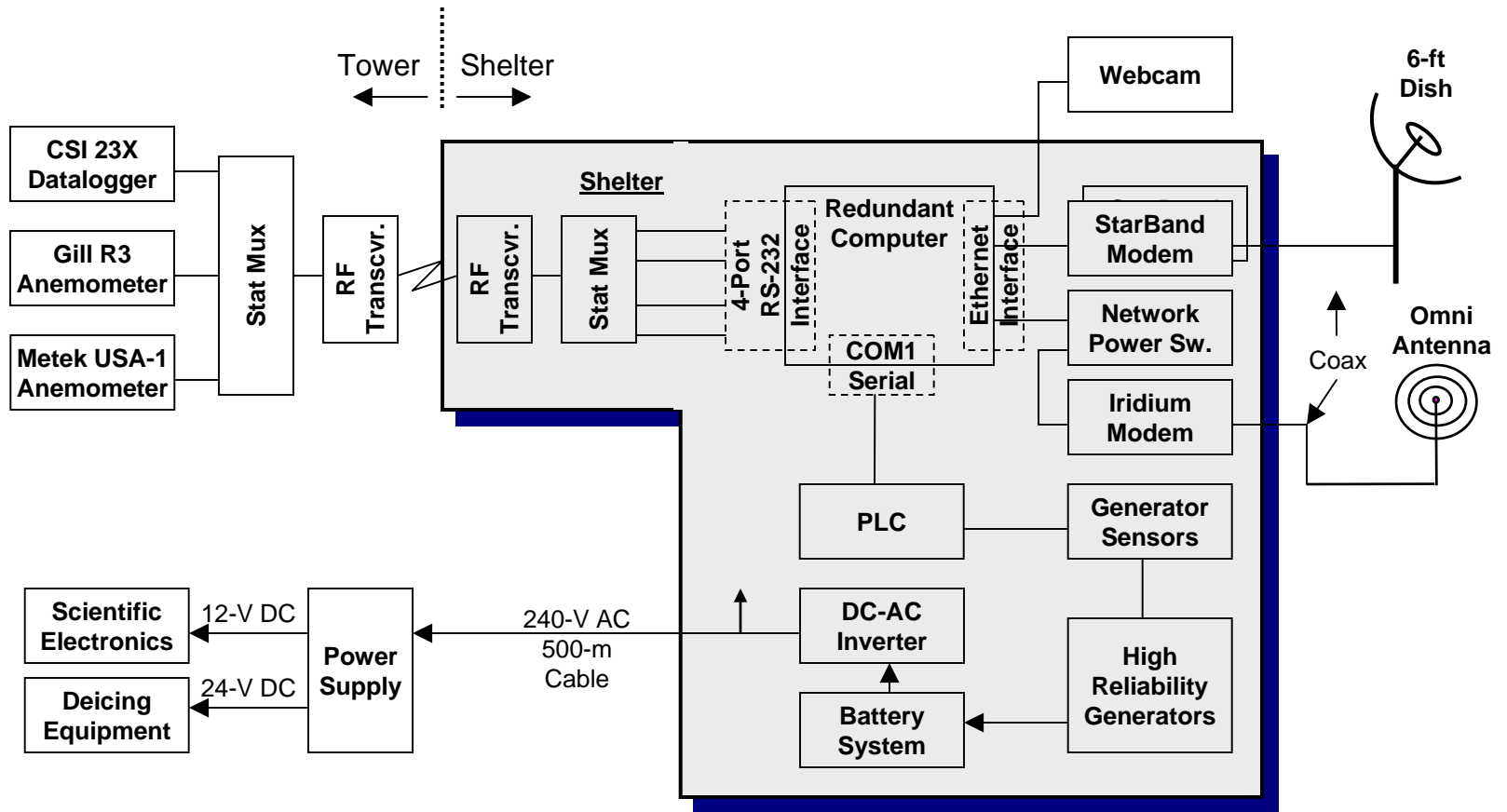


Peer-to-Peer Packet Radio Network

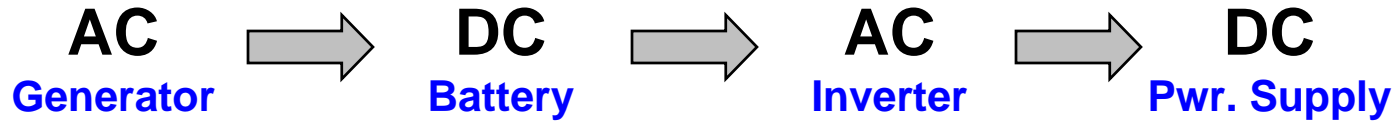
- **Mobile Ad-Hoc Network (MANET) protocols**
 - **Alternate routing for reliability and load sharing**
 - **Self-reconstituting for dynamic conditions**
- **Mostly practical in dense, mobile network**



Ivotuk System Schematic



Ivotuk System Power Considerations



- Science constraints dictated up to 1-km separation of Carbon-producing generators from measurement site

- High power drain for deicing heaters

- Minimize power loss in the cable

$$P_{\text{load}} = V * I$$
$$P_{\text{loss}} = I^2 * R_{\text{cable}}$$

- No Carbon byproducts from a Renewable Energy generator
 - Permits closer proximity to measurement site
 - Lower cable costs
 - Lower cable power losses

Common Elements

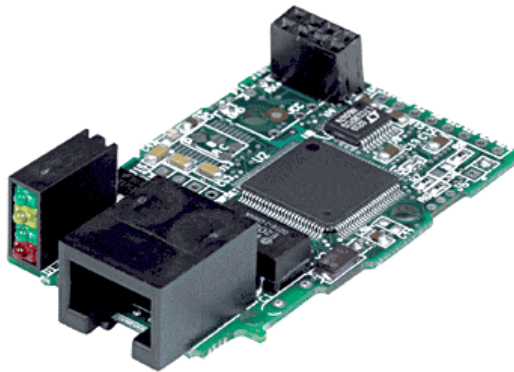
- **Control & Data Acquisition**
 - Sensor system
 - Power system
 - Communications system
 - Thermal control

- **Single Board Computers**
 - Rugged
 - Low power
 - Powerful as laptop



Ethernet Interfaces Becoming Common

- Common bus with wide IP address range
- Serial to Ethernet Interface
 - HTTP (Web), Telnet, FTP
 - TCP/IP, UDP/IP, ARP, ICMP, SNMP, DHCP
- - 40 to +85°C Operating temperature range
- Caution with power requirements (700 mW)
 - Intended for high speed data transfers



Newport iServer



Lantronix XPort

USB Bus Data Acquisition

- **Simple Data Acquisition Systems**
- **- 40 to +60°C Operating temperature range**

