An Internet-Based Interactive Embedded Data-Acquisition System for Real-Time Applications

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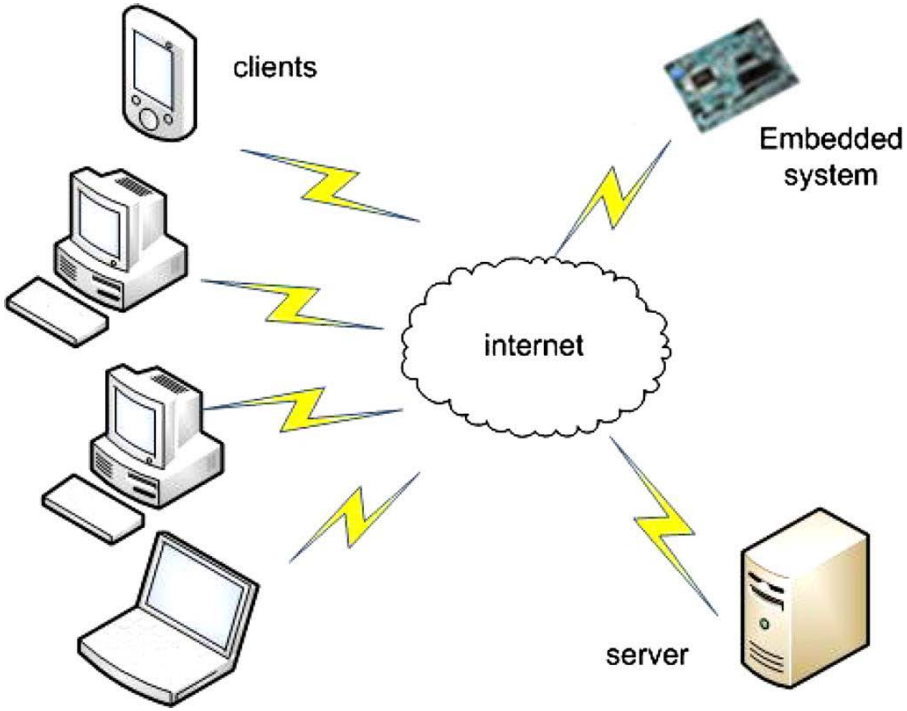
Agenda

- An Introduction to Data Acquisition Systems.
- Motivation
- Functional Block Diagram
- Proposed System
  - Hardware
  - Software
  - Direct Access to the Embedded System
  - Establishing a communication link
  - Data Management in the system
- Sample Application
  - Camera
  - GPS
  - Temperature Sensor
- Conclusion
- References

Data Acquisition System

- What is DAQ
- History
- Need of Data Acquisition



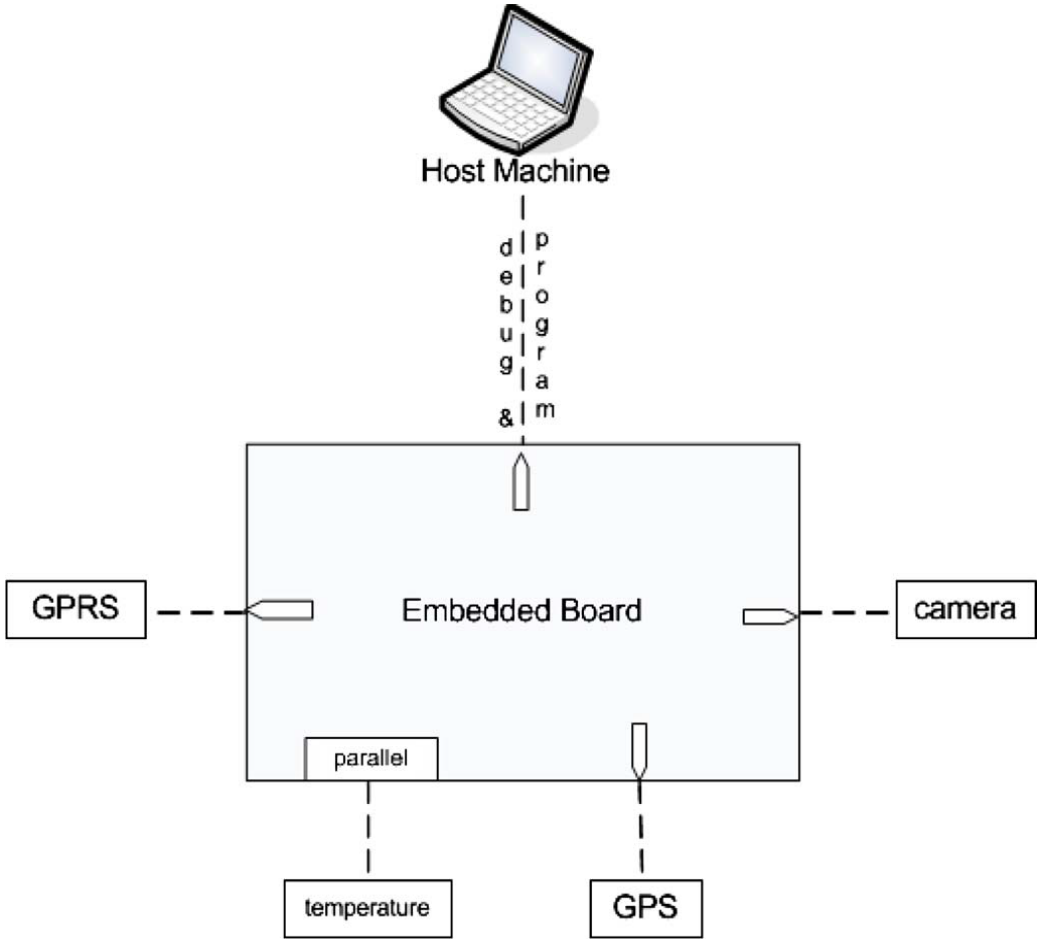
Motivation - Drawbacks of Traditional DAQ Systems

- Use data network without minimizing data transfer cost.
- Need to maintain additional server.
- Need to access the server every time.
- Unsuitable for Real Time control applications.

Motivation- Advantages of the Proposed System

- No need of an established server.
- Minimizes the cost of data transfer.
- Direct Communication link between the client and Embedded System.

Hardware

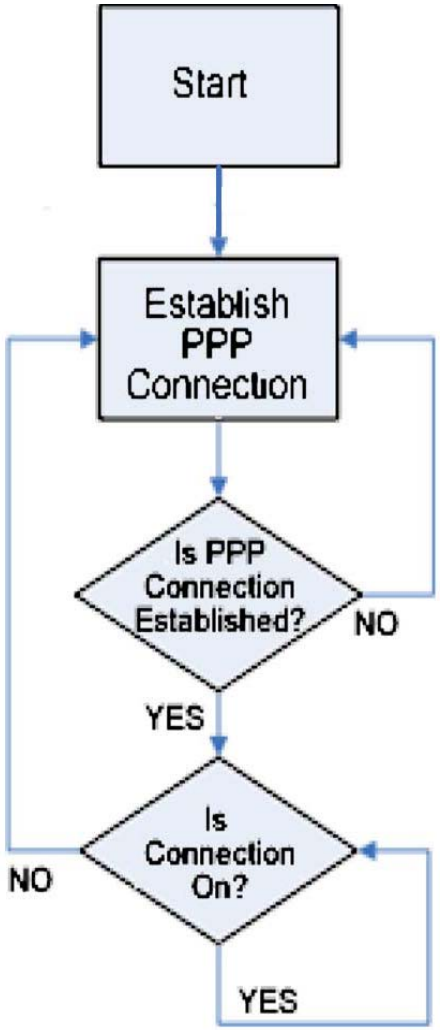


- X-86 Based Standalone unit
- Four Serial Ports, One Serial Port
- 16 MB on board removable flash memory
- Acquisition Units can be varied and added using appropriate interfaces

Software

- Linux 2.4 Kernel with TCP/IP stack included
- Only bare minimum packages installed
  e.g. Console tty, Serial Ports, PPPD, Support for memory and math emulation
- Scaled down version of Linux to reduce memory footprint and complexity

Establishing a Communication Link



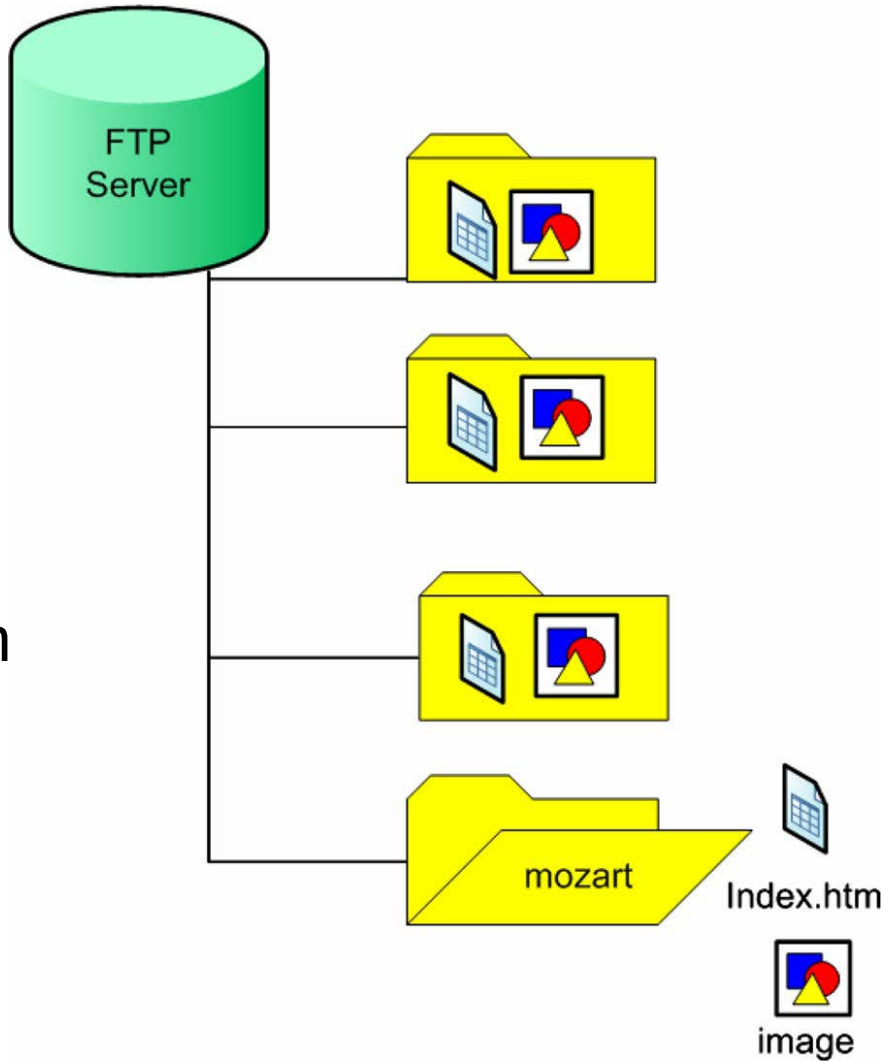
- Initiate GPRS connection using GPRS modem.
- Manage the Point to Point Protocol (PPP) connection using PPP Daemon (PPPD)
- GPRS parameters like connection speed are managed by PPPD.

Direct Access to the Embedded System

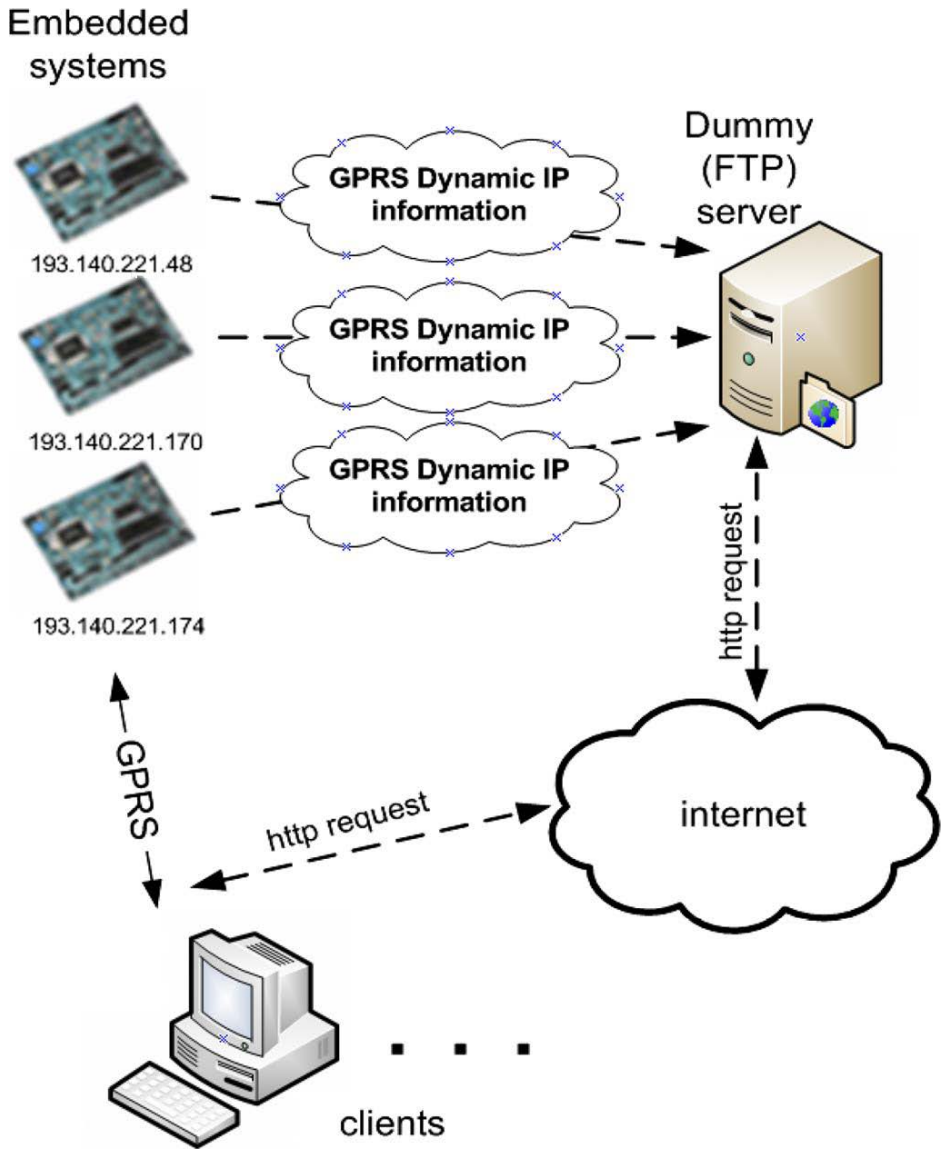
- For direct access, IP address of the Embedded Device must be known to Client.
- Static IP Vs. Dynamic IP
  - Static IP – Advantages & Disadvantages
  - Dynamic IP – Advantages & Disadvantages

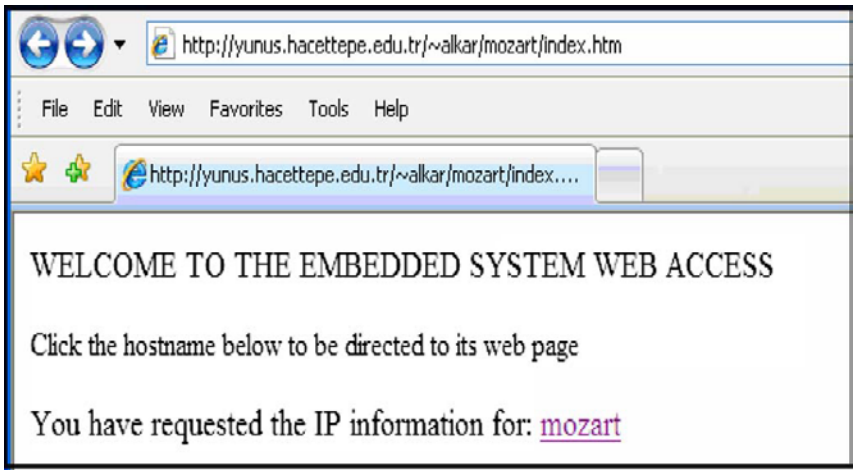
FTP

- Embedded Device updates its IP address
- It is saved in a folder named by its hostname
- This script parses the curren and sends it to FTP server

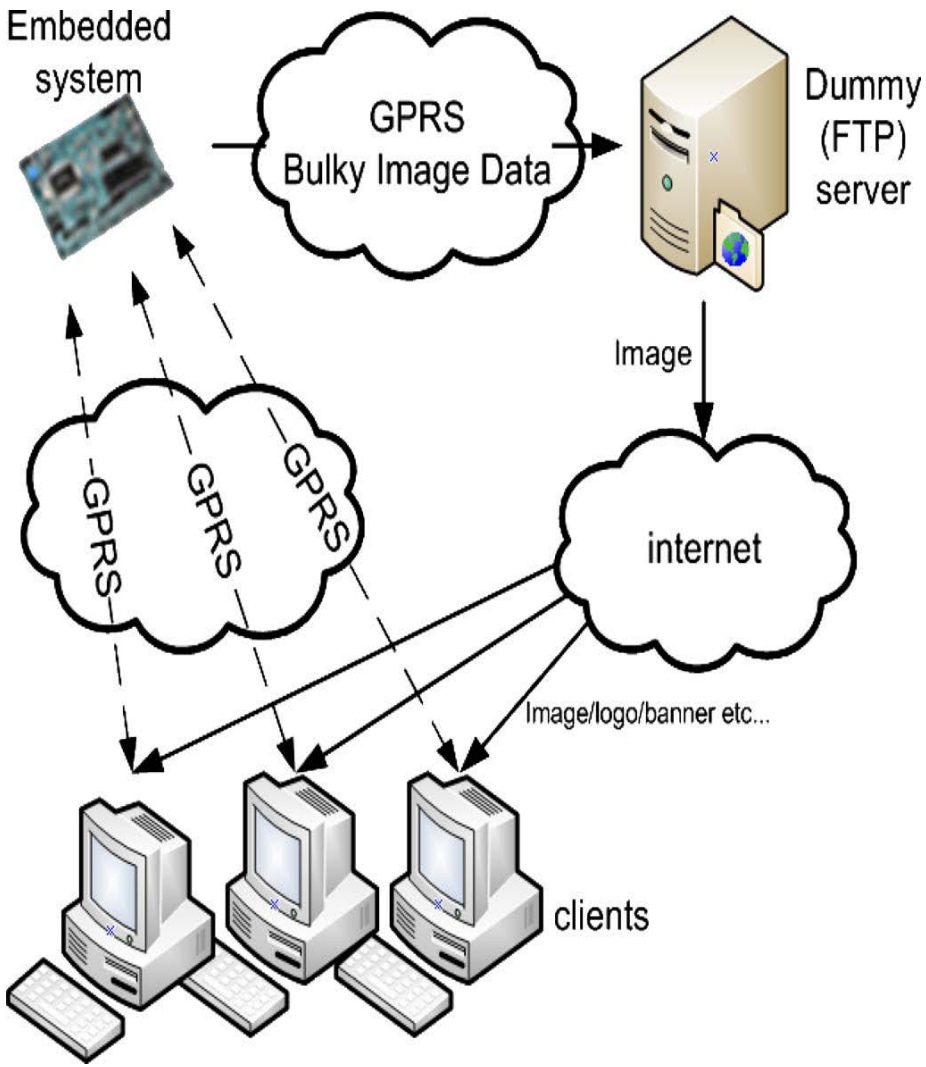


FTP – Continued





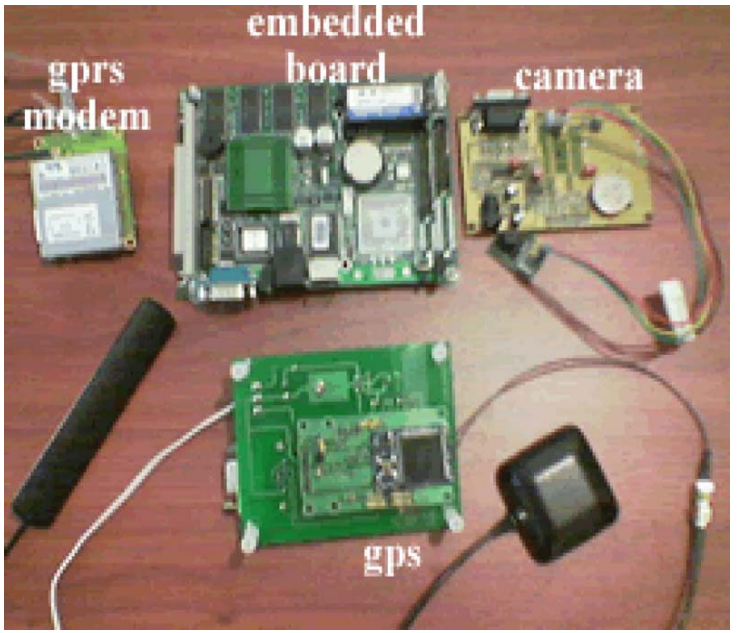
Data Management in the system



- Internet Server is used to decrease data management cost
- Text data is served by Embedded System
- Bulky data is sent only once using GPRS and placed on FTP server

Sample Application

- A camera, Temperature sensor and GPS are integrated into an embedded board to form a sample application
- A CMOS Camera with built in JPEG controller chip
- The GPS module - OEM GPS UV40
- A very low cost temperature measurement chip - DS1620



Camera

- The client initiates the camera control script, which eventually takes a snapshot
- The picture is uploaded to a dummy FTP server
- All the queries to visualize the current picture are automatically relayed to the FTP server

# of clients at the same time	Σ Duration (sec) to receive pictures	
	FTP server	Direct Access
1	21.77	21.77
2	21.77	40.14
3	21.77	58.51
4	21.77	76.88

Camera Pseudo code

```
Snapshot()

Connect Embedded_Board_to_Camera

  Send Synch packages to Synchronize

Wait until response received from camera

Take_Snapshot

  Camera_Execute_Snapshot

Receive_Snapshot

  Store_into_Flash

  Upload to FTP site

Close_Connection
```

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http://193.140.221.170/~www/snapshot.htm

File Edit View Favorites Tools Help

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Main Menu > > **Snapshot**

New Picture

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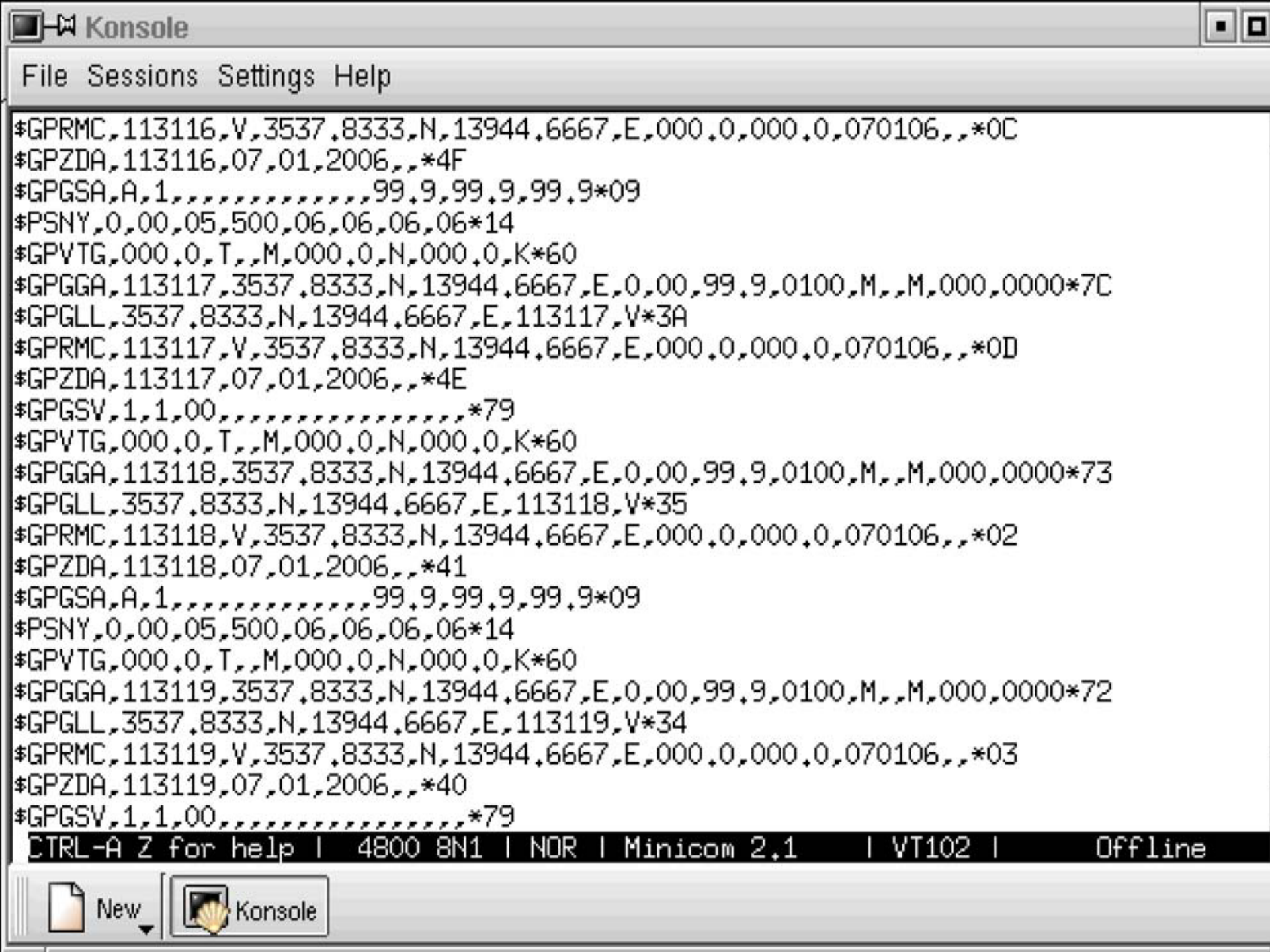
GPS

- The embedded board acquires raw data periodically.
- The program transfers the selected GPS data to the memory after compiling a bulk of raw data.
- The newest GPS data are exchanged with the oldest data using the memory as a FIFO buffer.

Interpreting Raw GPS data

```
$GPBOD - Bearing, origin to destination
$GPBWC - Bearing and distance to waypoint, great circle
$GPGGA - Global Positioning System Fix Data
$GPGLL - Geographic position, latitude / longitude
$GPGSA - GPS DOP and active satellites
$GPGSV - GPS Satellites in view
$GPHDT - Heading, True
$GPR00 - List of waypoints in currently active route
$GPRMA - Recommended minimum specific Loran-C data
$GPRMB - Recommended minimum navigation info
$GPRMC - Recommended minimum specific GPS/Transit data
$GPRTE - Routes
$GPTRF - Transit Fix Data
$GPSTN - Multiple Data ID
$GPVBW - Dual Ground / Water Speed
$GPVTG - Track made good and ground speed
$GPWPL - Waypoint location
$GPXTE - Cross-track error, Measured
$GPZDA - Date & Time
```


Konsole
File Sessions Settings Help
$GPRMC,113116,V,3537.8333,N,13944.6667,E,000.0,000.0,070106,,*0C
$GPZDA,113116,07,01,2006,,*4F
$GPGSA,A,1,,,,,,,,,,,,,99.9,99.9,99.9*09
$PSNY,0,00,05,500,06,06,06,06*14
$GPVTG,000.0,T,,M,000.0,N,000.0,K*60
$GPGGA,113117,3537.8333,N,13944.6667,E,0,00,99.9,0100,M,,M,000,0000*7C
$GPGLL,3537.8333,N,13944.6667,E,113117,V*3A
$GPRMC,113117,V,3537.8333,N,13944.6667,E,000.0,000.0,070106,,*0D
$GPZDA,113117,07,01,2006,,*4E
$GPGSV,1,1,00,,,,,,,,,,,,,,,,*79
$GPVTG,000.0,T,,M,000.0,N,000.0,K*60
$GPGGA,113118,3537.8333,N,13944.6667,E,0,00,99.9,0100,M,,M,000,0000*73
$GPGLL,3537.8333,N,13944.6667,E,113118,V*35
$GPRMC,113118,V,3537.8333,N,13944.6667,E,000.0,000.0,070106,,*02
$GPZDA,113118,07,01,2006,,*41
$GPGSA,A,1,,,,,,,,,,,,,99.9,99.9,99.9*09
$PSNY,0,00,05,500,06,06,06,06*14
$GPVTG,000.0,T,,M,000.0,N,000.0,K*60
$GPGGA,113119,3537.8333,N,13944.6667,E,0,00,99.9,0100,M,,M,000,0000*72
$GPGLL,3537.8333,N,13944.6667,E,113119,V*34
$GPRMC,113119,V,3537.8333,N,13944.6667,E,000.0,000.0,070106,,*03
$GPZDA,113119,07,01,2006,,*40
$GPGSV,1,1,00,,,,,,,,,,,,,,,,*79
CTRL-A Z for help | 4800 8N1 | NOR | Minicom 2.1 | VT102 | Offline
New
Konsole

Interpreting GPS data

$GPGGA

Global Positioning System Fix Data

Name	Example Data	Description
Sentence Identifier	$GPGGA	Global Positioning System Fix Data
Time	170834	17:08:34 Z
Latitude	4124.8963, N	41d 24.8963' N or 41d 24' 54" N
Longitude	08151.6838, W	81d 51.6838' W or 81d 51' 41" W
Fix Quality: - 0 = Invalid - 1 = GPS fix - 2 = DGPS fix	1	Data is from a GPS fix
Number of Satellites	05	5 Satellites are in view
Horizontal Dilution of Precision (HDOP)	1.5	Relative accuracy of horizontal position
Altitude	280.2, M	280.2 meters above mean sea level
Height of geoid above WGS84 ellipsoid	-34.0, M	-34.0 meters
Time since last DGPS update	blank	No last update
DGPS reference station id	blank	No station id
Checksum	*75	Used by program to check for transmission errors

Courtesy of Brian McClure, N8PQI.

GPGGA Information

- The GPGGA information is parsed from the raw data and stored in a file.

$GPGGA,151732.750,3952.1503,N,03244.1166,E,1,03,7.7,1172.4,M,,M,,0000*7A	
Type	$GPGGA
UTC time	151732
Latitude	3952.1503,N
Longitude	3244.1166,E
Number of Satellites Connected	03
Altitude	1172.4,M

Visually tracking the system using GPS

- The system can be set to visually track the current location of the embedded system on a map.
- An icon that represents a vehicle is inserted into the location using basic frames in html, utilizing the latest coordinate information from the GPS data
- The GPS accuracy of the measurements is less than 15 m

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Main Menu

- LAST INFORMATION
- VELOCITY GRAPHICS
- ALTITUDE GRAPHICS
- VELOCITY ARCHIVE
- TEMPERATURE
- LAST NEW PHOTO

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BACK <<

Temperature

- Low cost temperature measurement chip (DS1620) is used to collect ambient temperature

- Accuracy of 0.5 ◦C.
- This chip is attached to the parallel port of the embedded board.
- A daemon is initiated at boot time to sample and display the temperature every 30 s for a time interval of 15 min.

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http://193.140.221.170/~www/temper.htm

File Edit View Favorites Tools Help

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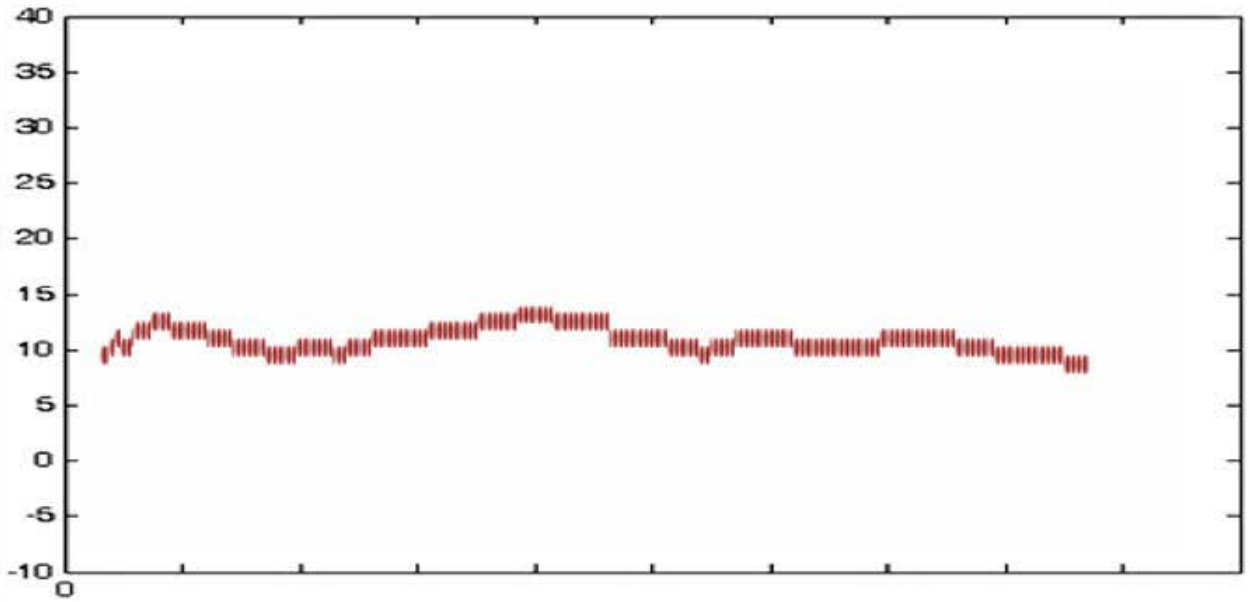
Main Menu > > Temperature Graphics



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Conclusion

- Compared with traditional DAQ systems, this system has following advantages
  - Allowing direct bidirectional communication
  - Reducing overhead.
  - The operational costs have been reduced

- Future Scope:
  - Power Conservation

References

1. http://aprs.gids.nl/nmea/
2. GPS fix data - Courtesy of Brian McClure, N8PQI.www.slat.org/project
3. www.wikipedia.com
4. Photos Retrieved From: Google Image Search