Cloud-based Data Logging, Monitoring and Analysis

Measurement System

Using Windows Azure, SQL Server, LabVIEW and Visual Studio/C#

Hans-Petter Halvorsen, M.Sc.
System Overview

Data Logging

PC, Arduino, Raspberry Pi, ...

Database

Server

Data Monitoring

PC, Tablet, Smartphone, ...

Sensors
System Overview

Data Logging
- DAQ
- DAQmx Driver
- Stored Procedure(s)

Database
- Trigger(s)
- Views and/or Stored Procedure(s)
- Data Analysis
- Convert Temperature to Fahrenheit
- Calculate Average, Max, Min Temperature Data

Data Monitoring
- Visual Studio

Data Analysis
Cloud Hosting and Services
Cloud Hosting

They rent Cloud based services like Virtual Machines (Computers with OS running in the Cloud), Web Server, Database Systems to Customers based on Monthly Fees
Windows Azure

Hans-Petter Halvorsen, M.Sc.
Windows Azure

“Windows running in the Cloud”
Create SQL Server Database in Windows Azure
Windows Azure Database
Windows Azure Database
Connect to Windows Azure Database from Local Computer
Datalogging using LabVIEW

Hans-Petter Halvorsen, M.Sc.
Datalogging using LabVIEW

- TC-01 Thermocouple
- DAQ
- LabVIEW
- Windows Azure
- Microsoft SQL Server
- Stored Procedure(s) and Triggers in SQL Server
- Convert Temperature to Celsius/Fahrenheit
- The Cloud
- Calculate Average, Max, Min Temperature Data
- The Cloud

Diagram:
- TC-01 Thermocouple connected to DAQ, then to LabVIEW.
- LabVIEW connects to Microsoft SQL Server.
- Data is transferred to and from SQL Server.
- SQL Server contains stored procedures and triggers.
- The Cloud symbolizes cloud-based storage or processing.
LabVIEW HMI Example

The Temperature Data from the TC-01 DAQ device should be stored in the Database.
Data Monitoring using Visual Studio/C#

Hans-Petter Halvorsen, M.Sc.
Data Monitoring using Visual Studio/C#
### Temperature Data:

<table>
<thead>
<tr>
<th>Date &amp; Time</th>
<th>Value [C]</th>
<th>Value [F]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016.03.22 14:45</td>
<td>22</td>
<td>71.6</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

**Chart**

**Data Monitoring App**

- **Average:** 22°C
- **Min:** 10°C
- **Max:** 26°C

You should get the Data from the Database.

Typically you get Data from the Database using Views and/or Stored Procedures.
Web Services

Hans-Petter Halvorsen, M.Sc.
Problem
How to Share Data between Devices in a Network?

Direct Connection between the Database and the Clients that need the Data is normally not possible, due to security, compatibility issues, etc. (Firewalls, Hacker Attacks, etc.)

Direct Connection in a Local Network (behind the Firewall) is normally OK – but not over the Internet!!
Web Services uses standard Web Protocols like HTTP, etc. HTTP is supported by all Web Browser, Servers and many Programming Languages.
Web Services

- A Web service is a method of communications between two devices over the World Wide Web.
- Web API
- Standard defined by W3C
- Cross-platform
- Web Services can be implemented and used in most Programming Languages (C#/ASP.NET, PHP, LabVIEW, Objective-C, Java, ...)
- Uses standard Web Technology and Web Protocols
  - HTTP, REST, SOAP, XML, WSDL, JSON, ...
Each app uses the same API to get, update and manipulate data. All apps have feature parity and when you need to make a change you just make it in one place in line with the ‘Don’t Repeat Yourself’ (DRY) principle of software development. The apps themselves then become relatively lightweight UI layers.

System Overview

Data Logging

DAQ

DAQmx Driver

Data Analysis

Business Logic

Web Service

Database

Microsoft SQL Server

The Cloud

Data Logic

Data Monitoring

Visual Studio
Web Services running in Windows Azure

In Windows Azure you can Deploy

• Web Sites
• Web Services
etc.
=> App Services
Create App Service from Azure Portal
Hans-Petter Halvorsen, M.Sc.

University College of Southeast Norway

www.usn.no

E-mail: hans.p.halvorsen@hit.no
Blog: http://home.hit.no/~hansha/