

Industry 4.0, Internet of Things (IoT), Cloud Computing



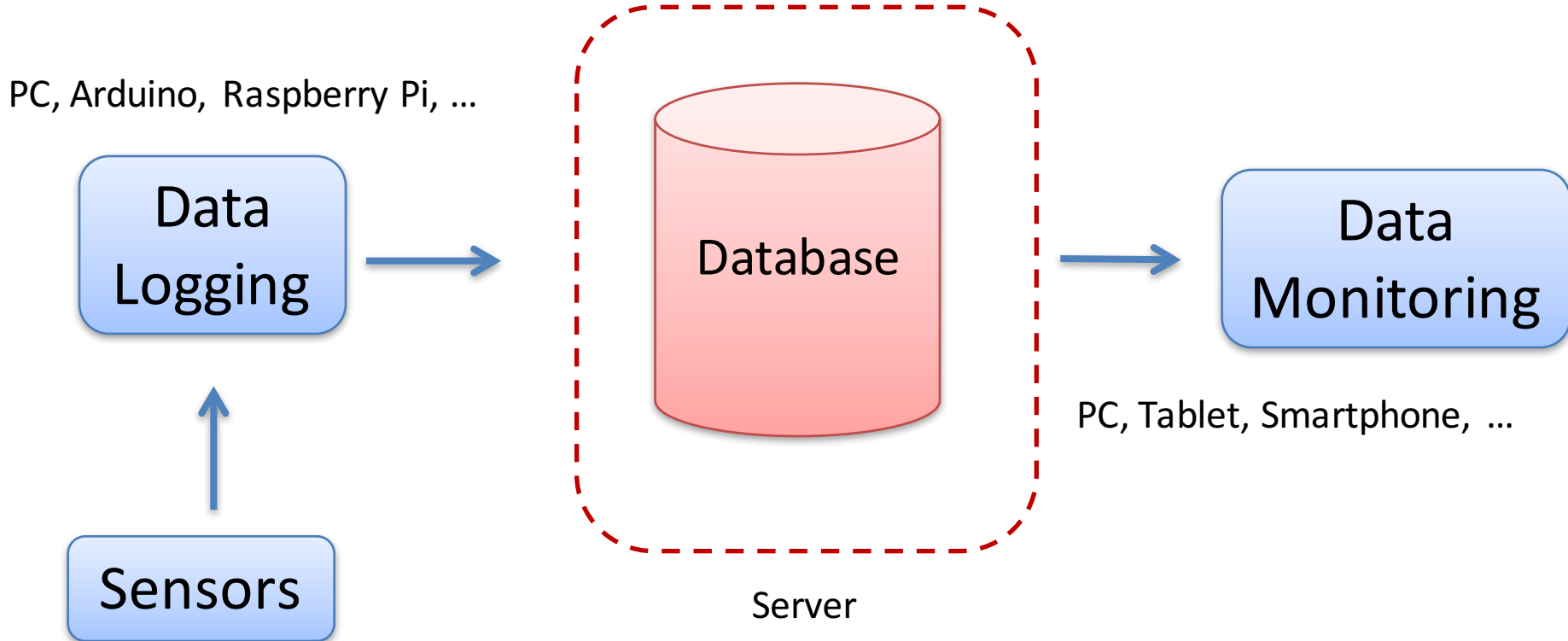
Cloud-based Data Logging, Monitoring and Analysis

Measurement System

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

Hans-Petter Halvorsen, M.Sc.

System Overview



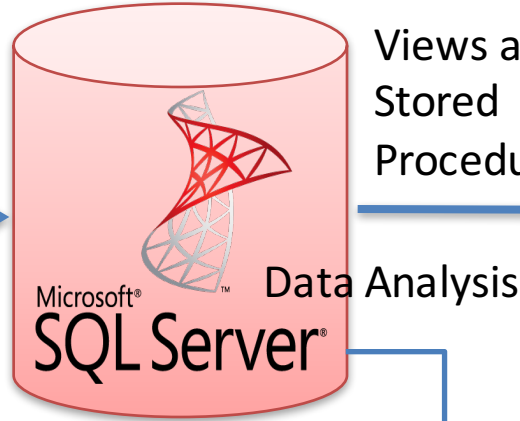
System Overview

Data Logging



Stored Procedure(s)

Database



Views and/or Stored Procedure(s)

Data Monitoring



Data Analysis

Trigger(s)

DAQmx Driver

DAQ



Convert Temperature to Fahrenheit

Calculate Average, Max, Min Temperature Data



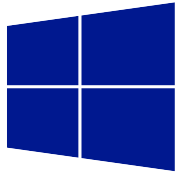
The Cloud



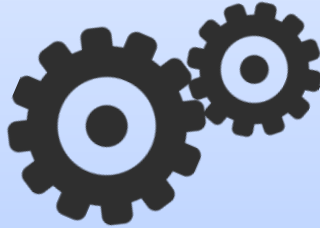
Cloud Hosting and Services

Hans-Petter Halvorsen, M.Sc.

Cloud Hosting



Windows Azure



amazon
web services™

Google Cloud Platform

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

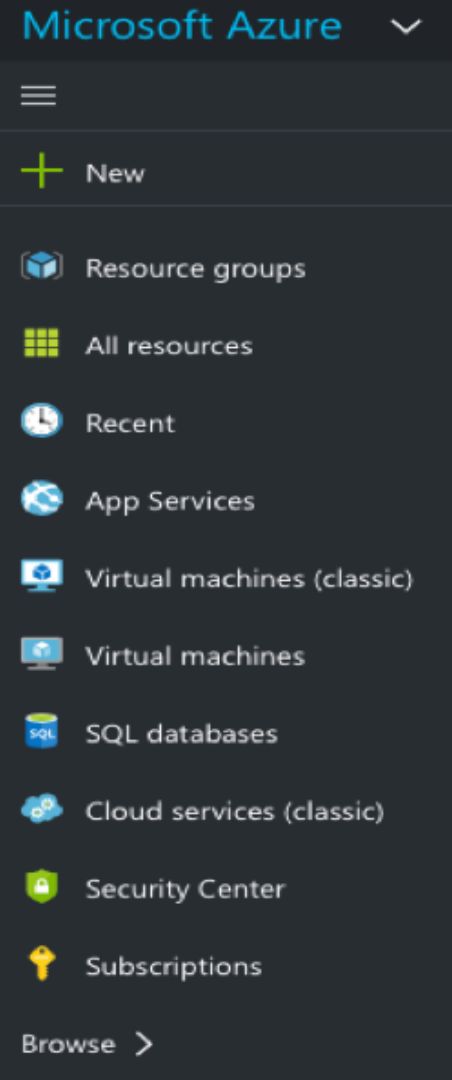
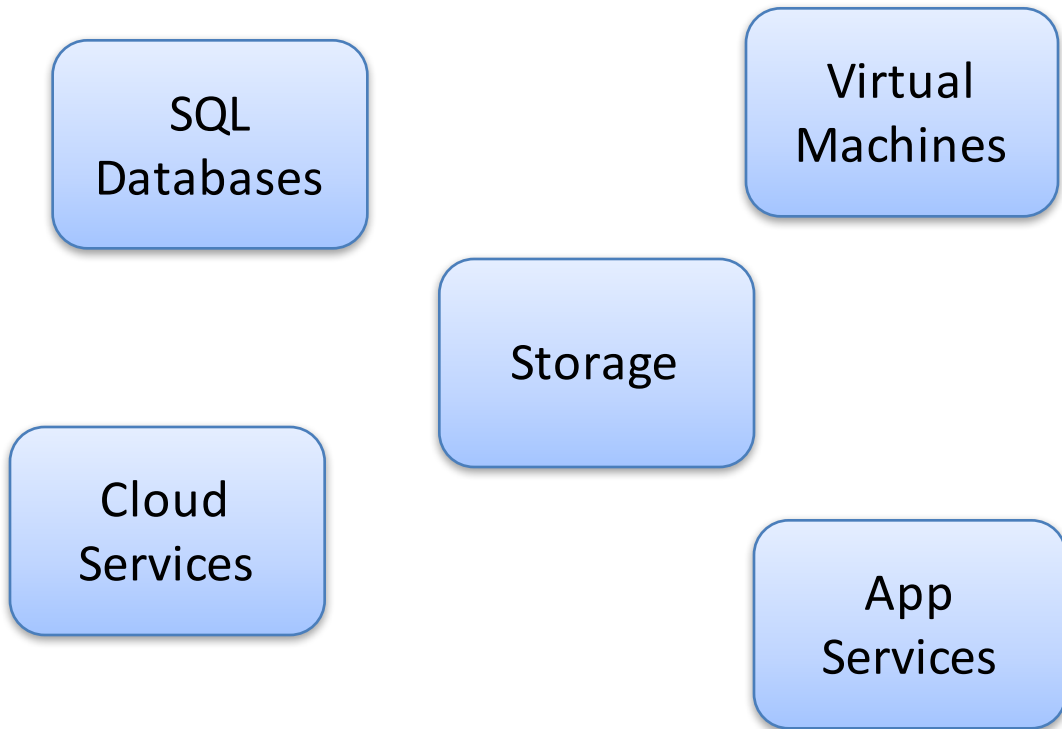


Windows Azure

Hans-Petter Halvorsen, M.Sc.

Windows Azure

“Windows running in the Cloud”



Create SQL Server Database in Windows Azure

The screenshot displays the Microsoft Azure portal interface for creating a new SQL Database. The left-hand navigation pane shows the 'SQL databases' category highlighted with a red box. The main content area is titled 'SQL Database' and contains a form with the following fields and options:

- Name:** A text input field with the placeholder text 'Enter database name'.
- Server:** A link labeled 'Configure required settings'.
- Select source:** A dropdown menu with 'Blank database' selected.
- Pricing tier:** A dropdown menu with 'S0 Standard' selected.
- Optional configuration:** A dropdown menu with 'Collation' selected.
- Resource group:** A dropdown menu with 'Group' selected.
- Subscription:** A dropdown menu with 'Azure Pass' selected.


Below the form, there is a checkbox for 'Pin to dashboard' and a blue 'Create' button.

On the right side, a pricing card for the 'B Basic' tier is shown, featuring a star icon. The card details include:

- 5 DTUs**
- Up to 2GB**
- Point In Time Restor...**
- Auditing**
- 35.21 NOK/MONTH (ESTIMATED 31 BASL..)**

Windows Azure Database

The screenshot displays the Microsoft Azure portal interface for SQL databases. The top header shows 'Microsoft Azure' and 'SQL databases' with search, notification, and user icons. The left sidebar lists various Azure services, with 'SQL databases' selected. The main content area shows 'SQL databases' with 'Default Directory' and options to 'Add', 'Columns', or 'Refresh'. Below this is a search bar and a table of database instances.

NAME	STATUS	REPLICATION ROLE	SERVER	PRICING TIER
 MEASUREMENTSYSTEM	Online	None	hph	Basic

System Overview

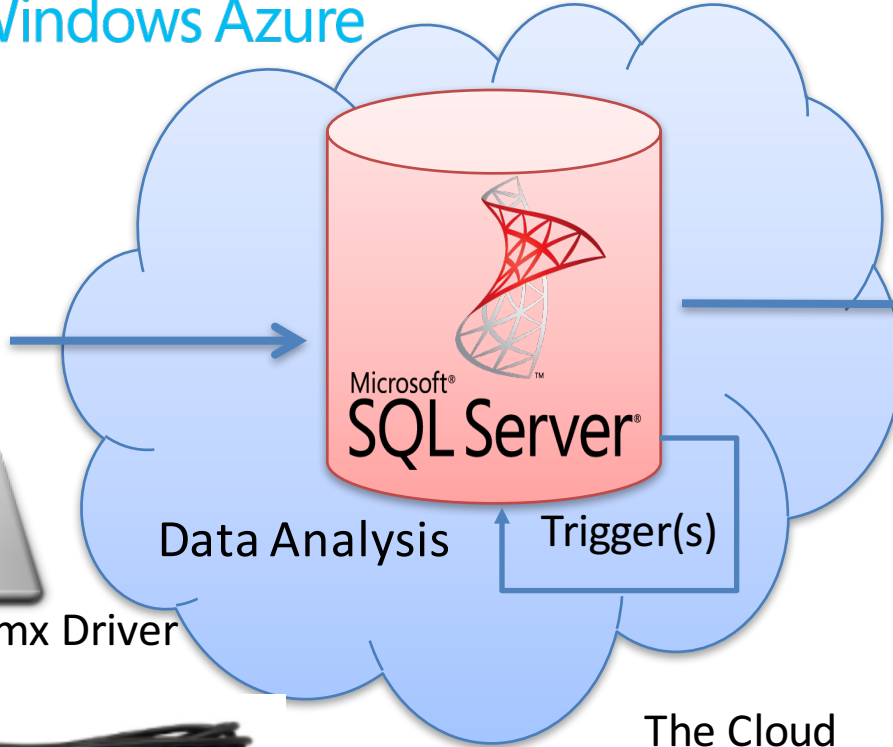


Data Logging



DAQmx Driver

DAQ



Data Analysis

Trigger(s)

The Cloud

Data Monitoring






SQL Server

Database Implementation and Structured Query Language (SQL)

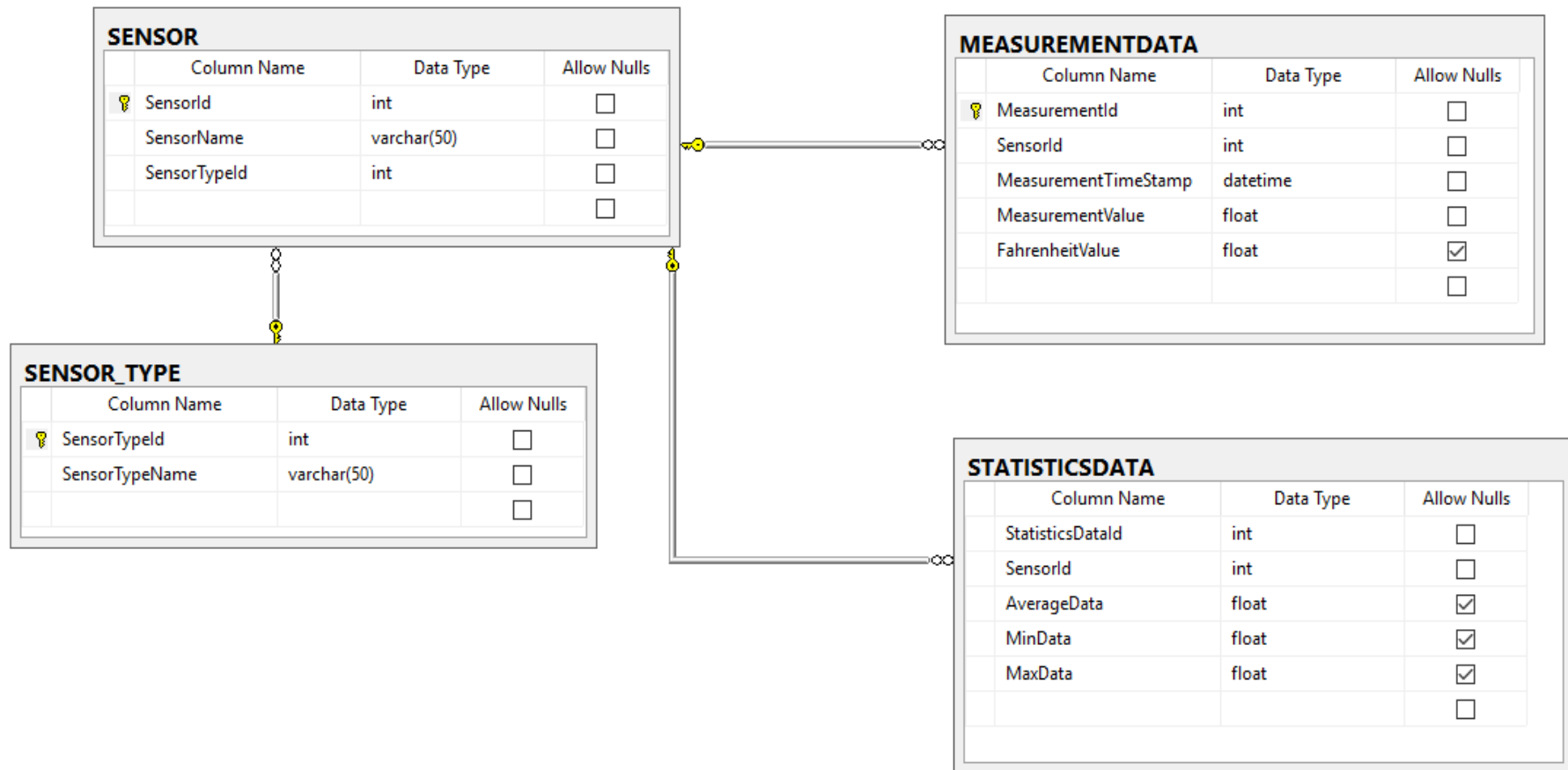
Hans-Petter Halvorsen, M.Sc.

Windows Azure Database

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NAME	STATUS	REPLICATION ROLE	SERVER	PRICING TIER
 MEASUREMENTSYSTEM	Online	None	hph	Basic

Database



Connect to Windows Azure Database from Local Computer

The screenshot displays the Microsoft SQL Server Management Studio (SSMS) interface. The main window shows a query window with the following SQL query:

```
select * from MEASUREMENTDATA
```

The results window displays the following data:

MeasurementId	Measurement Time Stamp	SensorId	MeasurementValue	FahrenheitValue
1	2016-04-08 10:57:20.830	1	23,9	75,02
2	2016-04-08 10:57:21.273	1	23,8	74,84
3	2016-04-08 10:57:22.273	1	23,8	74,84
4	2016-04-08 10:57:23.267	1	23,9	75,02
5	2016-04-08 10:57:24.277	1	25	77
6	2016-04-08 10:57:25.277	1	26,2	79,16
7	2016-04-08 10:57:26.273	1	27	80,6
8	2016-04-08 10:57:27.273	1	27,2	80,96
9	2016-04-08 10:57:28.273	1	27,3	81,14
10	2016-04-08 10:57:29.280	1	27,2	80,96
11	2016-04-08 10:57:30.277	1	27,3	81,14

The Properties window on the right shows the connection parameters for the current connection:

- Connection 1
- Elapsed time: 00:00:00.0970350
- Finish time: 08.04.2016 12.58.56
- Name: hph.database.winc
- Rows returned: 20
- Start time: 08.04.2016 12.58.56
- State: Open
- Connection: Connection 1 hph.database.winc
- Connection Details: Connection 1: 00:00:00.0970350, Connection 1: 08.04.2016 12.58.56, Connection 1: 20, Connection 1: 08.04.2016 12.58.56, Connection 1: Open
- Display name: hph.database.winc
- Login name: hansha
- Server name: hph.database.winc
- Server version: 12.0.703
- Session TraceID: 45DE5A53-266C-40
- SPID: 51

The status bar at the bottom indicates the current connection: Query e... | hph.database.windows.net (1... | hansha (51) | MEASUREMENTSYSTEM | 00:00:00 | 20 rows



Datalogging using LabVIEW

Hans-Petter Halvorsen, M.Sc.

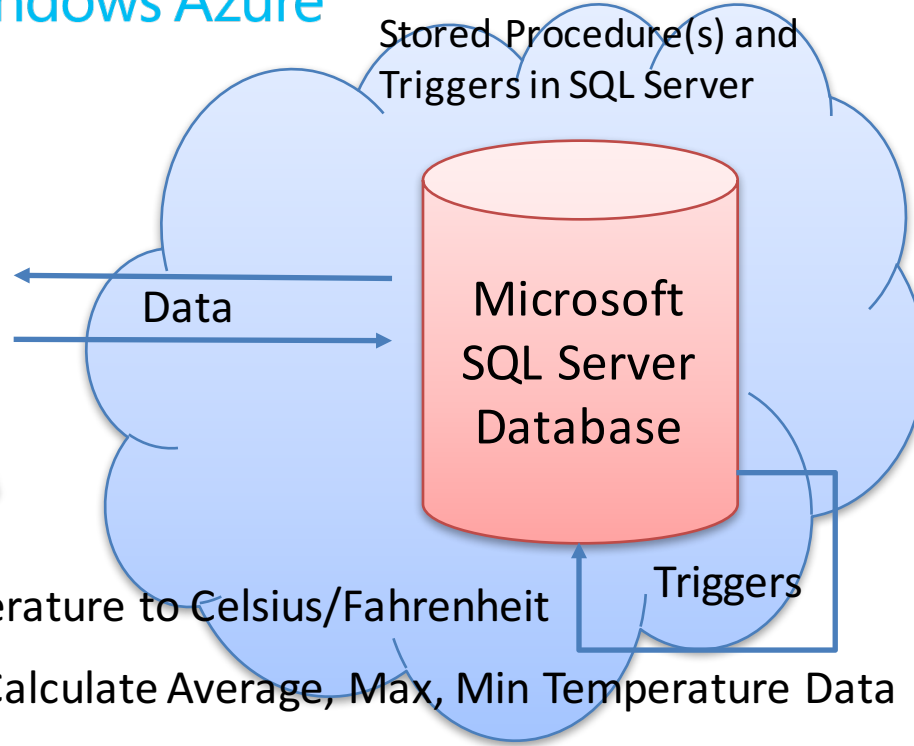
Datalogging using LabVIEW



TC-01 Thermocouple



DAQ



Stored Procedure(s) and Triggers in SQL Server

Data

Microsoft SQL Server Database

Triggers

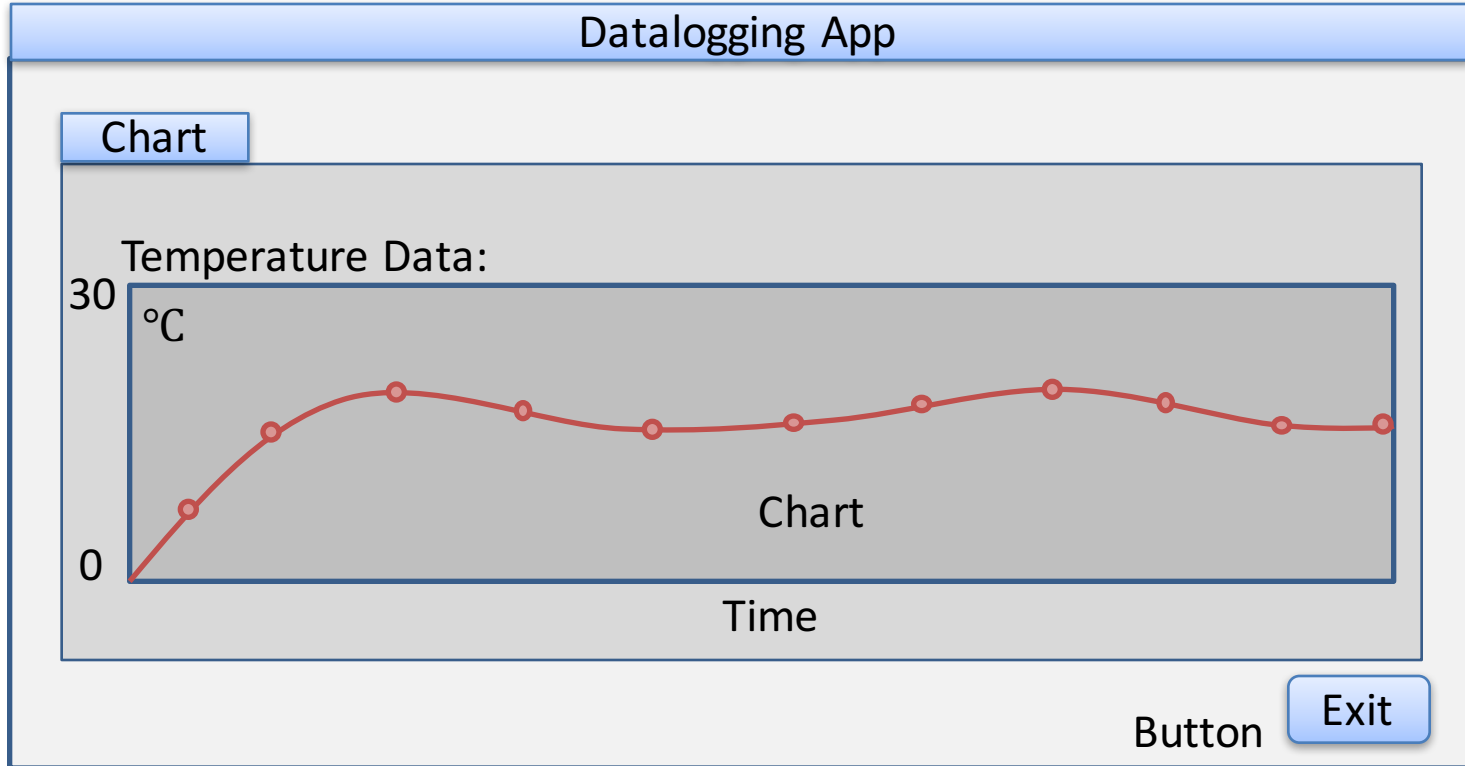
Convert Temperature to Celsius/Fahrenheit

Calculate Average, Max, Min Temperature Data

The Cloud

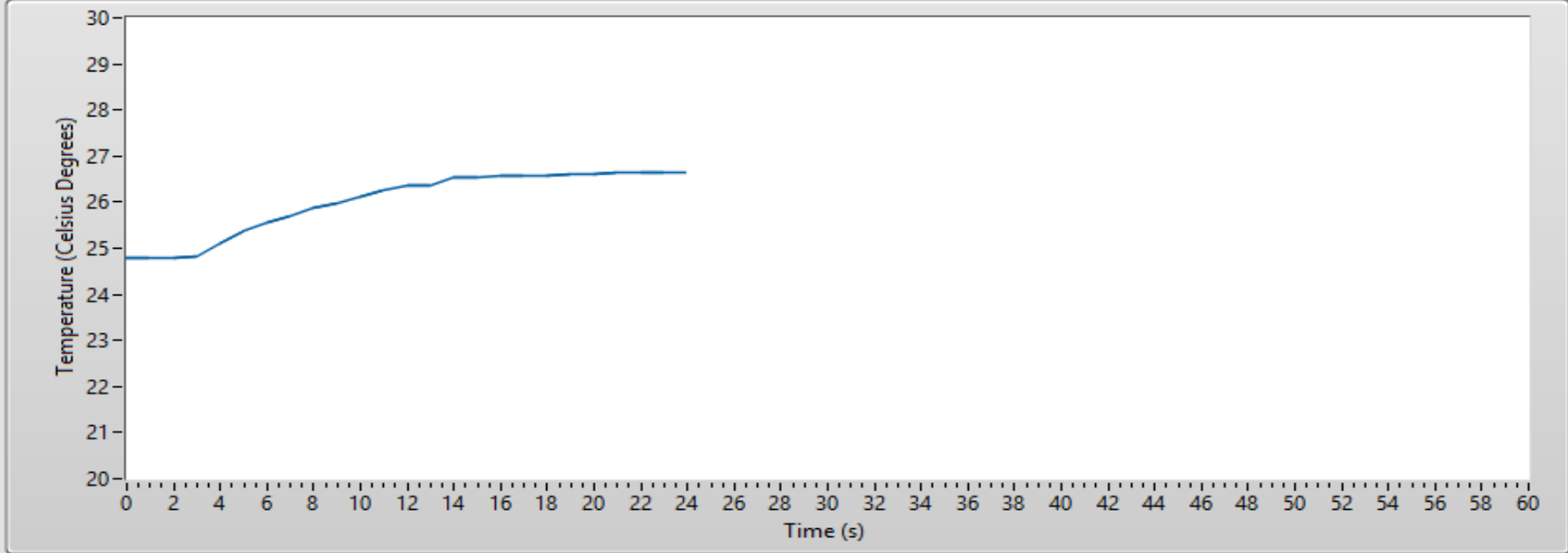
LabVIEW HMI Example

The Temperature Data from the TC-01 DAQ device should be stored in the Database.



Waveform Chart

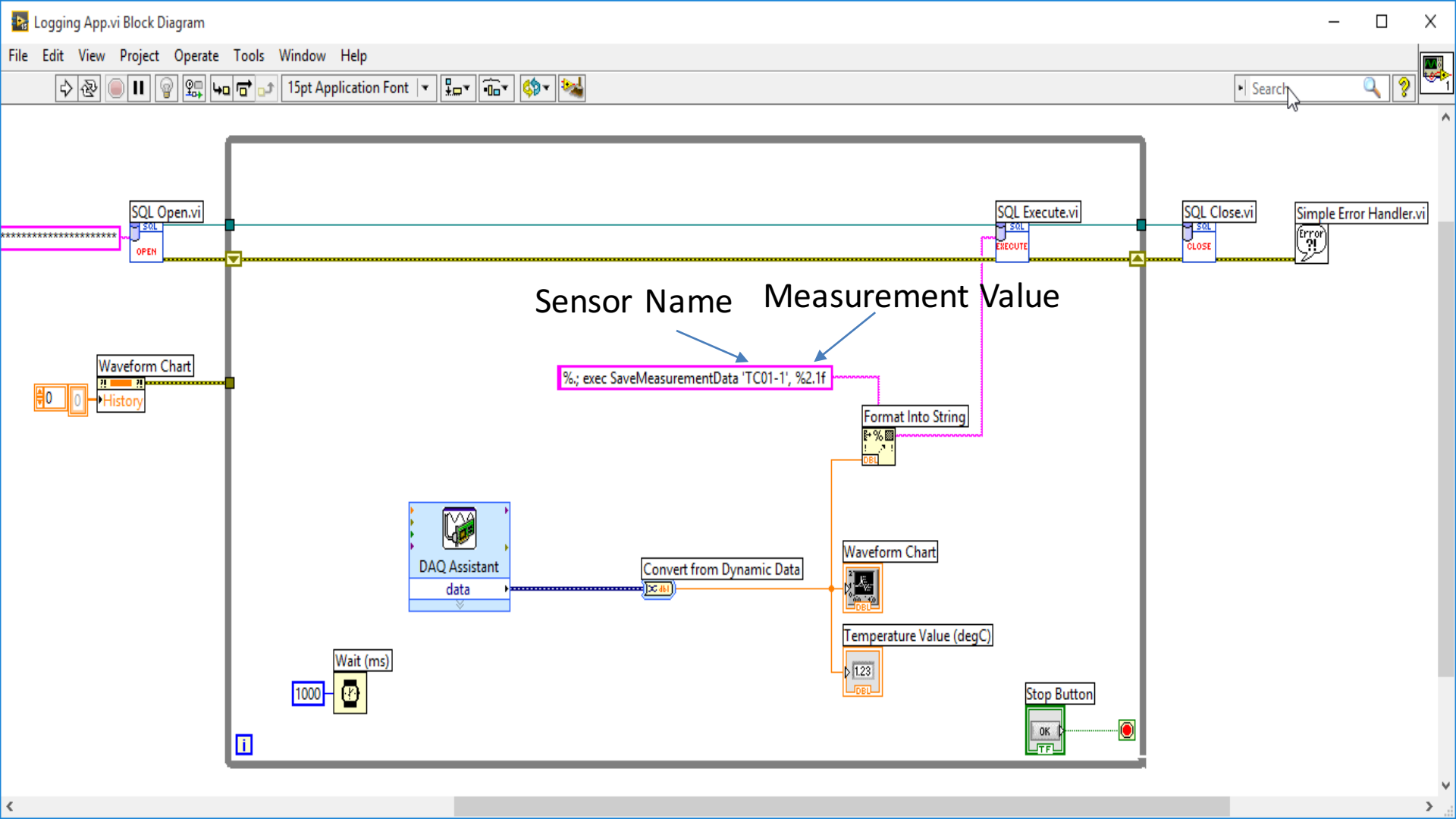
Plot 0 [Line Icon]



Temperature Value (degC)

26,7

■ Stop



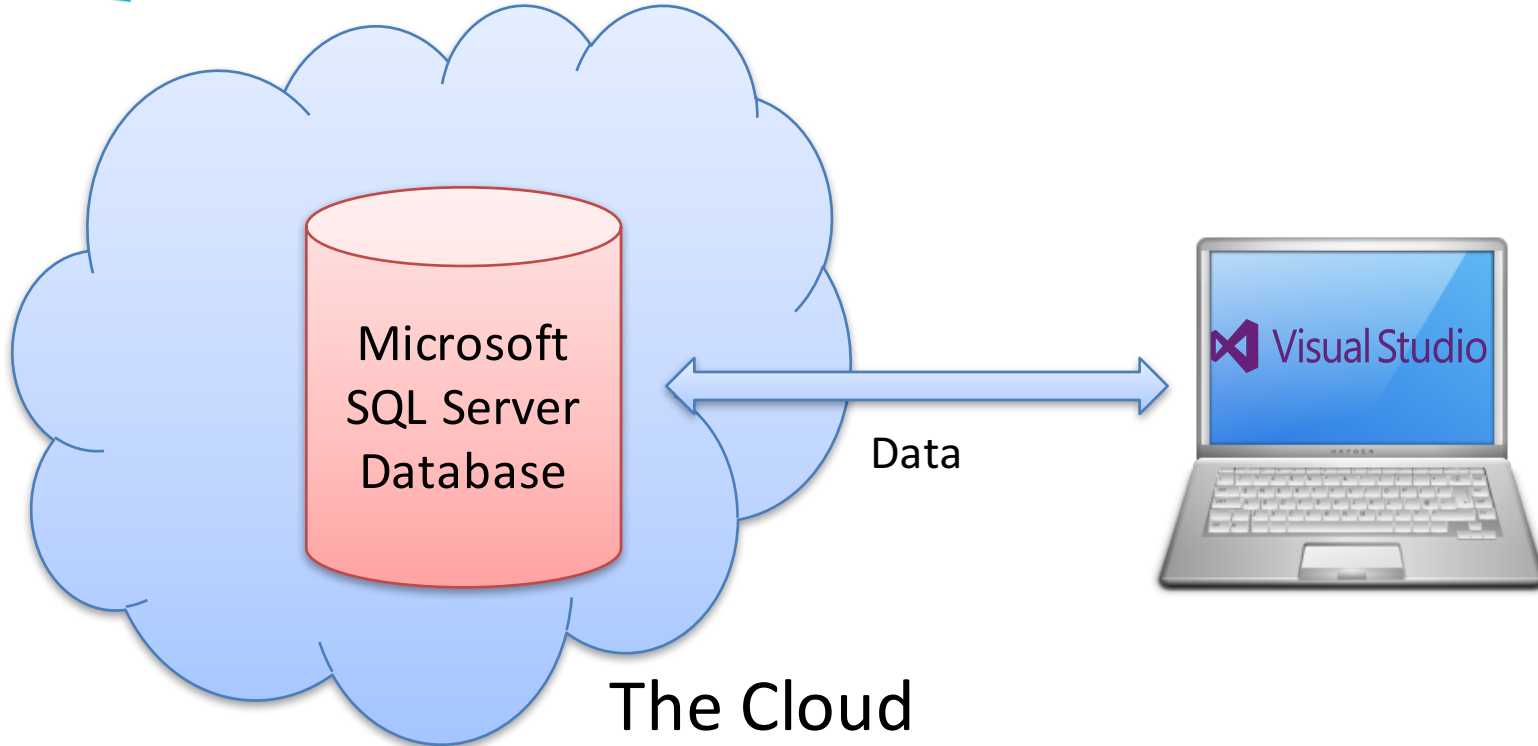
DEMO



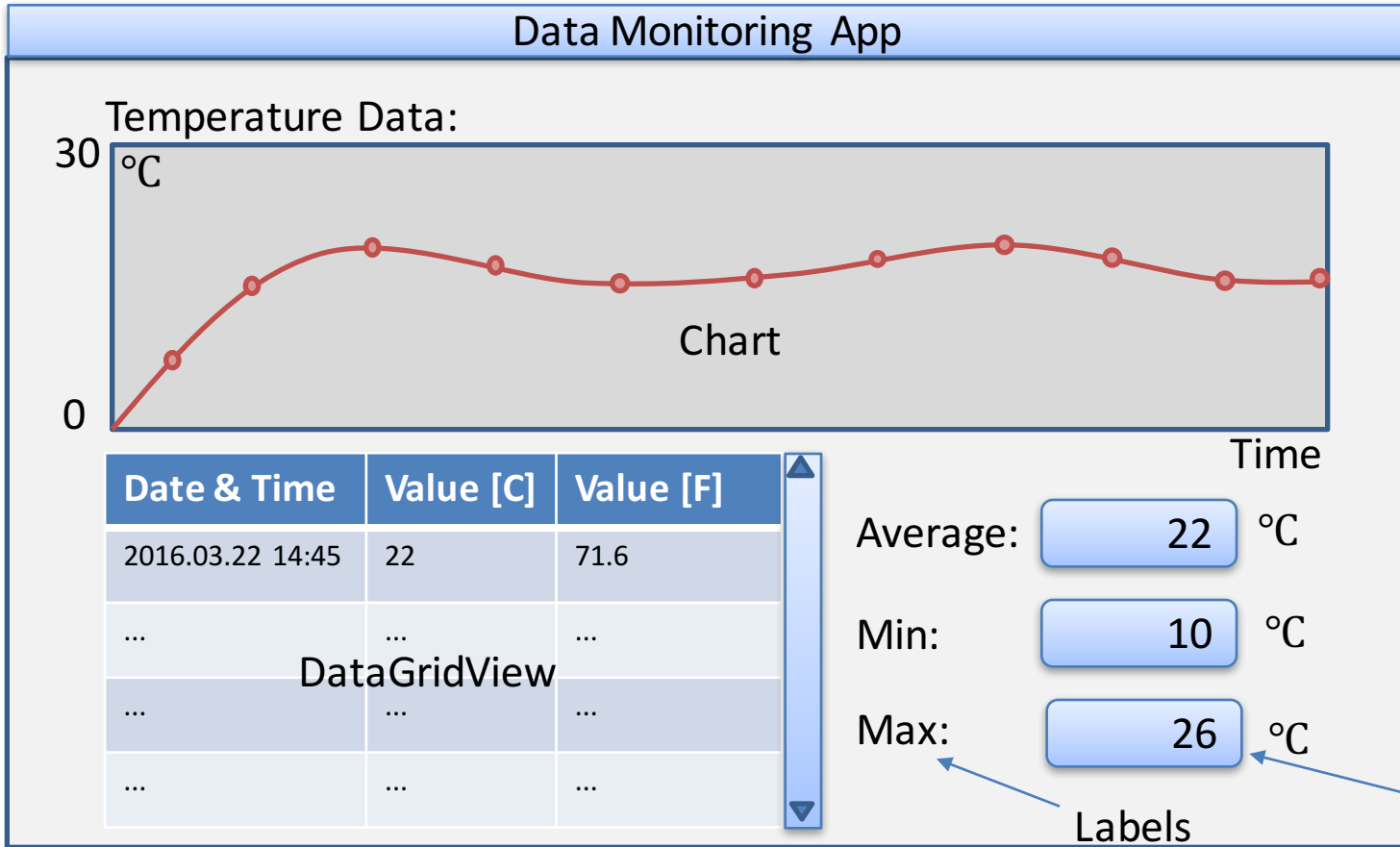
Data Monitoring using Visual Studio/C#

Data Monitoring using Visual Studio/C#

 Windows Azure



Visual Studio HMI Example

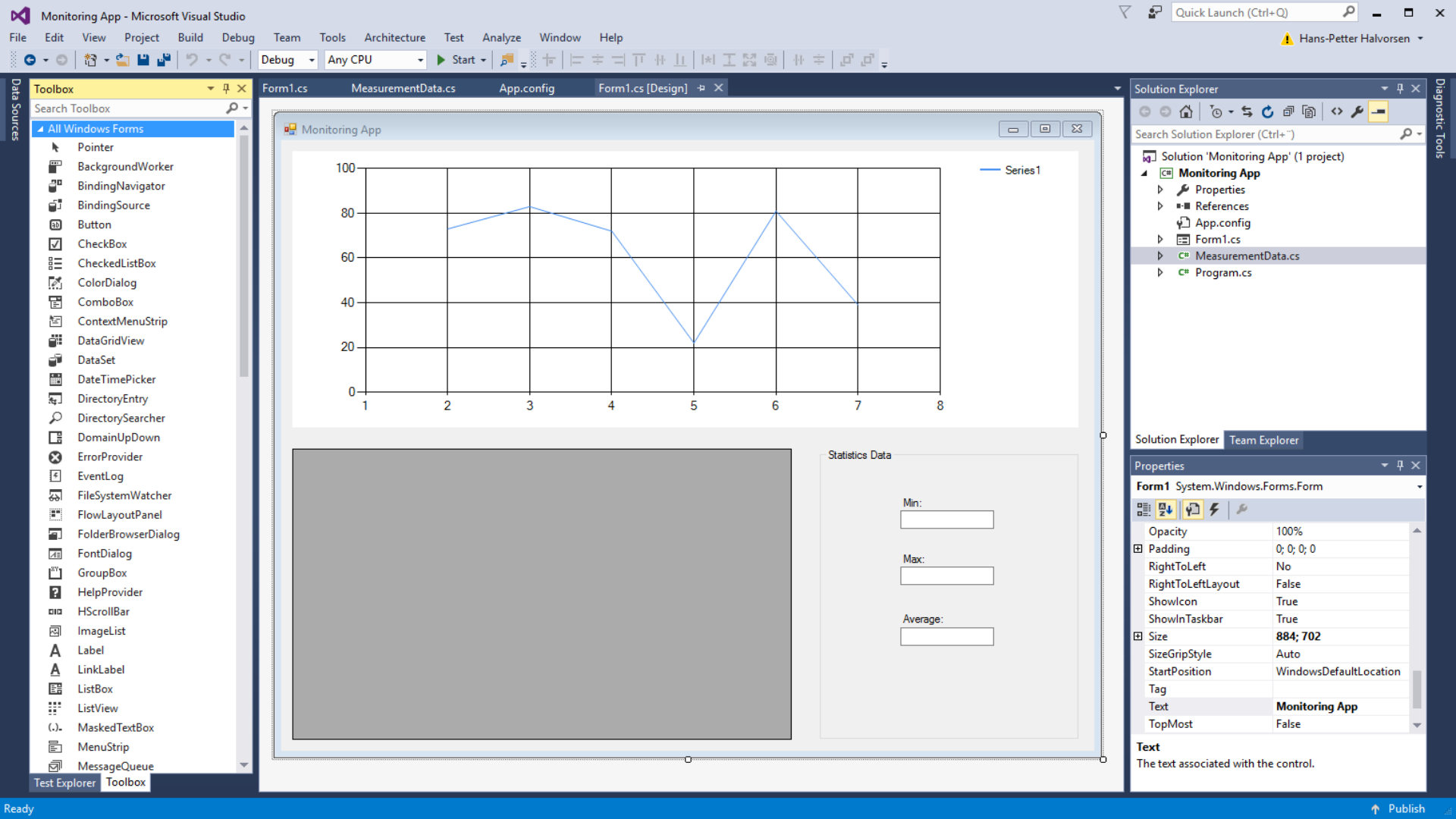


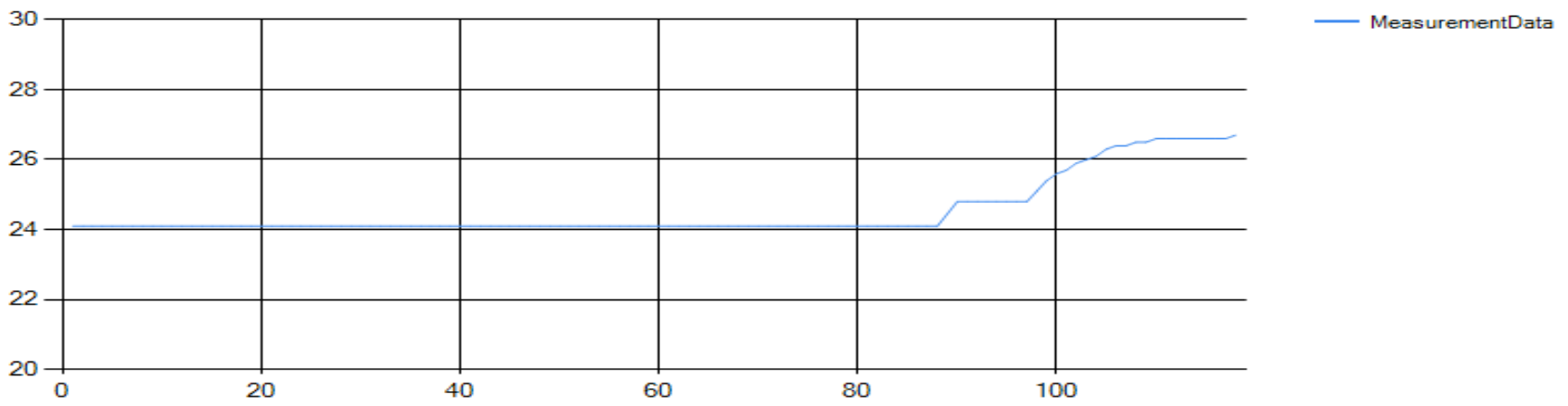
You should get the Data from the Database

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

Labels

TextBoxes





	MeasurementId	MeasurementTimeStamp	MeasurementValue	FahrenheitValue	^
▶	1	07.04.2016 10.44	24,1	75,38	
	2	07.04.2016 10.44	24,1	75,38	
	3	07.04.2016 10.44	24,1	75,38	
	4	07.04.2016 10.44	24,1	75,38	
	5	07.04.2016 10.44	24,1	75,38	
	6	07.04.2016 10.44	24,1	75,38	
	7	07.04.2016 10.44	24,1	75,38	
	8	07.04.2016 10.44	24,1	75,38	
	9	07.04.2016 10.44	24,1	75,38	
	10	07.04.2016 10.44	24,1	75,38	
	11	07.04.2016 10.44	24,1	75,38	
	12	07.04.2016 10.44	24,1	75,38	
	13	07.04.2016 10.44	24,1	75,38	▼

Statistics Data

Min:

Max:

Average:

DEMO



Web Services

Hans-Petter Halvorsen, M.Sc.

Problem

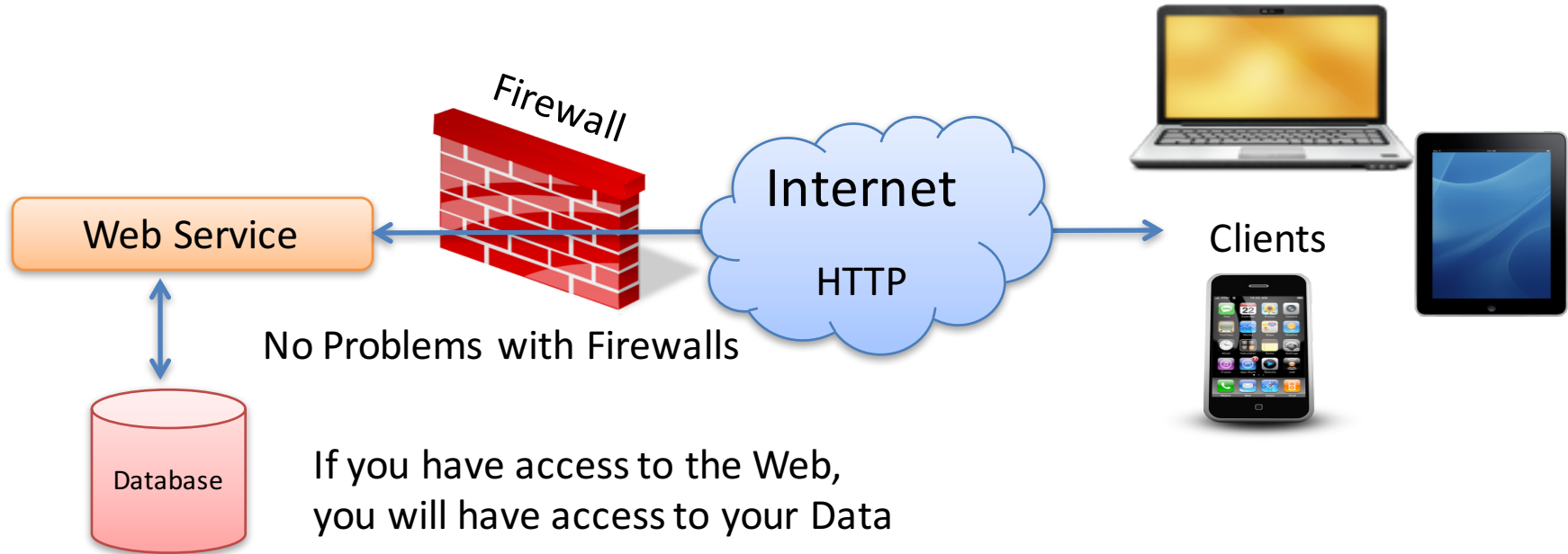
How to Share Data between Devices in a Network?



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!!

Solution: Web Service



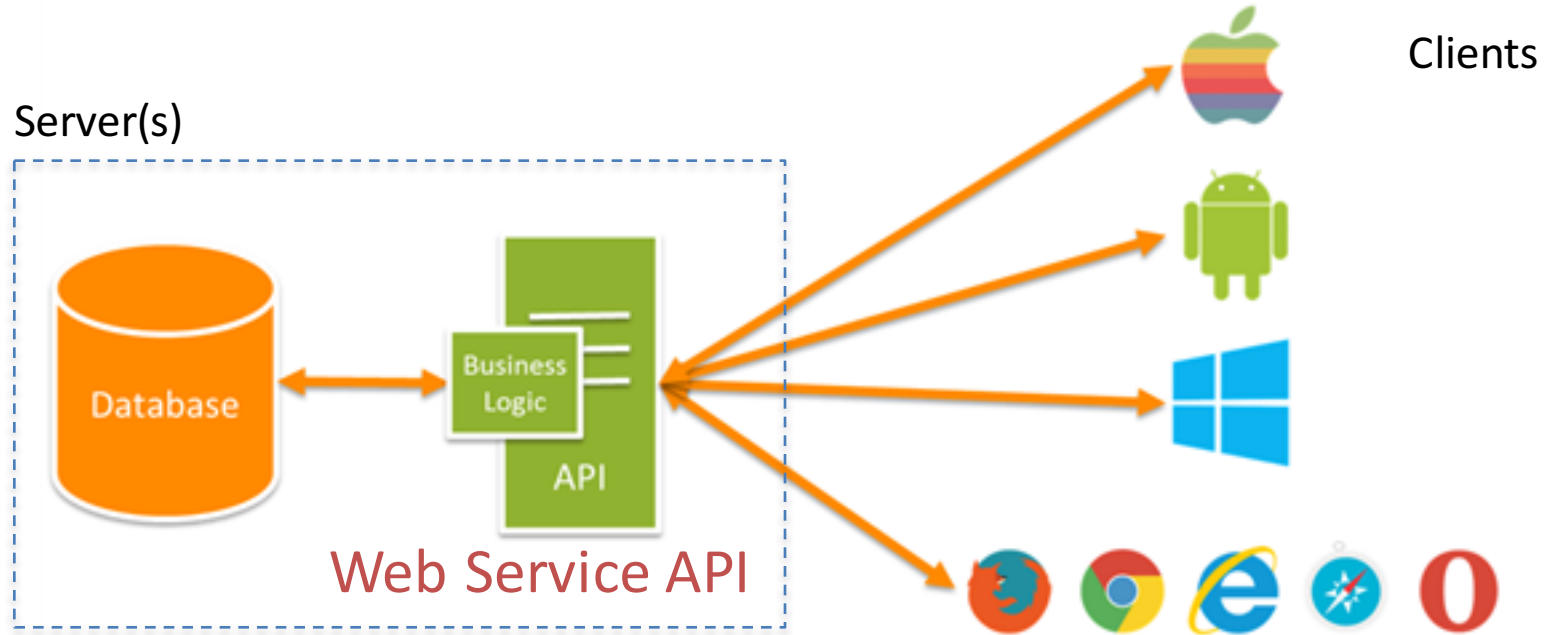
Web Services uses standard Web Protocols like HTTP, etc.

HTTP is supported by all Web Browser, Servers and many Programming Languages

Web Services

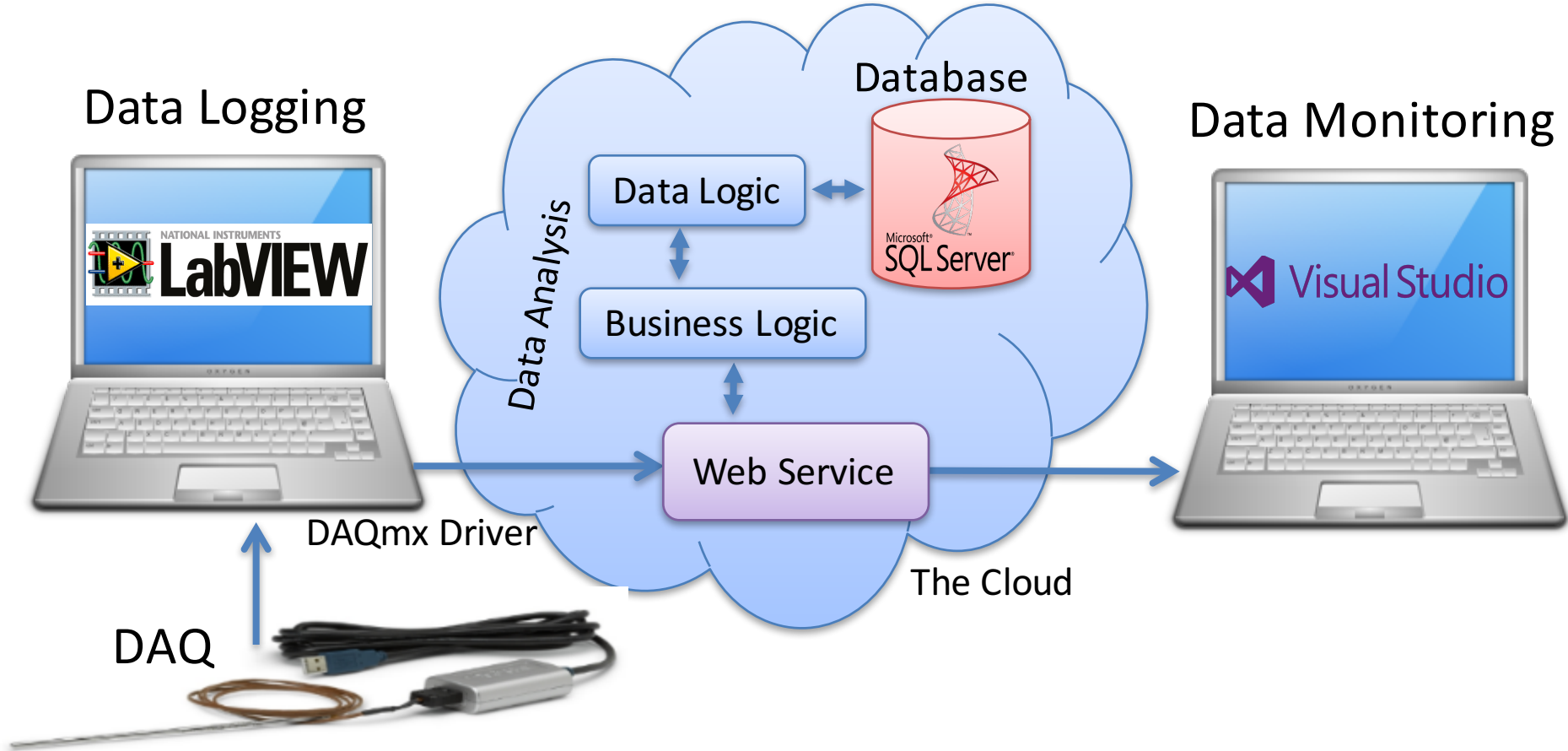
- A Web service is a method of communications between two devices over the World Wide Web.
- Web API
- Standard defined by W3C
- Cross-platform
- Web Services can be implemented and used in most Programming Languages (C#/ASP.NET, PHP, LabVIEW, Objective-C, Java, ...)
- Uses standard Web Technology and Web Protocols
 - HTTP, REST, SOAP, XML, WSDL, JSON, ...

Web Service Architecture Example



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



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

The screenshot displays the Azure Portal interface for creating a new Web App. The breadcrumb navigation at the top shows 'Microsoft Azure' > 'App Services' > 'Web App'. The left-hand navigation pane includes options like 'New', 'Resource groups', 'All resources', 'Recent', 'App Services' (highlighted with a red box), 'Virtual machines (classic)', 'Virtual machines', 'SQL databases', 'Cloud services (classic)', 'Security Center', and 'Subscriptions'. The main content area is titled 'Web App' and contains the following configuration fields:

- * App name:** A text input field with the placeholder text 'Enter a name for your App'. This field is highlighted with a red rectangular box.
- * Subscription:** A dropdown menu currently set to 'Azure Pass'.
- * Resource Group:** A dropdown menu currently set to '+ New'. Below it is a text input field for 'New resource group name'.
- * App Service plan/Location:** A dropdown menu currently set to 'ServicePlan85d480b0-8962(Sout...)' with a right-pointing chevron.

At the bottom of the form, there is an unchecked checkbox labeled 'Pin to dashboard' and a blue 'Create' button.

Hans-Petter Halvorsen, M.Sc.



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