

**MetSim: A Tool for the Simulation of
Meteorological Sensors and Verification of New AWOS**

Stefan Waas, Mario Schewski
Deutscher Wetterdienst (DWD)
Frahmredder 95, 22393 Hamburg, Germany
+49 40 6690-2456 (Tel.), -2499 (Fax)
E-Mail: Stefan.Waas@dwd.de, Mario.Schewski@dwd.de

ABSTRACT

The German Meteorological Service (DWD) will replace all automatic weather observing systems (AWOS) at the 16 international German airports. All existing sensors as well as the communication infrastructure of the present installation have to be reused for the new system called "ASDUV_E", which is presently being finalized by the company Telvent Netherlands. For acceptance tests – and later routine testing – a sensor simulator was commissioned to facilitate the testing of the communication between all sensors and the data acquisition systems and the correctness of the AWOS data processing.

The simulator – called 'MetSim' – is capable to simulate all sensors of a fully equipped airport (at least 130 instruments) including static values, predefined runs with added statistical variation as well as the replay of recorded weather data of real sensors from the field.

Sensor telegrams can be modified and new sensor types can be defined by configuration without changing the program code.

An essential feature is the ability to compare all parameters in real-time to the values determined by the AWOS under test including derived values, METARs, SPECIs, data telegrams to air traffic control (ATC) etc. The structure and the scope of the sensor simulation tool are presented.

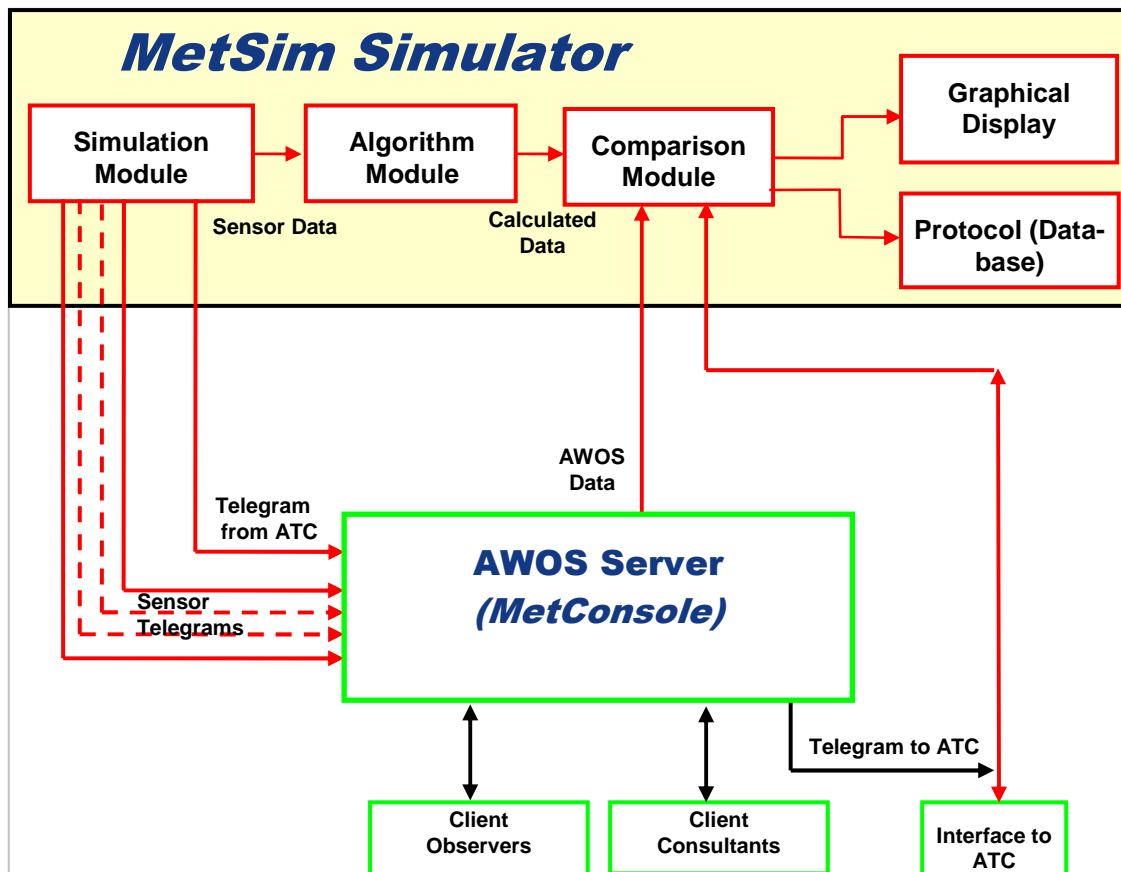


Fig. 1: Outline of MetSim modules and test setup.

Simulation Module

The test tool MetSim includes a simulation module to generate the data messages of all sensors types presently used at the different airports (e.g. MOR, wind speed and direction, pressure, temperature, humidity, clouds). The sensor data created in the simulation module is arbitrarily adjustable. The simulated values can be changed via keyboard or mouse. The test tool also allows the users to set the different possible states of a sensor such as 'defective', 'heater failure', 'power fault' or 'windows contaminated'.

The simulator is capable to simulate all sensors of a fully equipped airport including static values, predefined runs with added statistical variation as well as the replay of pre-recorded weather data of real sensors from the field. The time characteristics of each sensor is selectable from different presets (linear, step, curved). Sensor telegrams can be modified and new sensor types can be defined by configuration without changing the program code. Also generated by MetSim is the information from the ATC tower such as runway direction or information on runway illumination, transmitted as XML telegrams.

The sensor data telegrams are finally sent to the AWOS under test, and internally to the algorithm module where the data is processed by the algorithms as defined by DWD.

Algorithm Module

This module uses the algorithms as defined in appropriate regulations to calculate all corresponding meteorological parameters (e.g. RVR, QNH, tail and cross wind, cloud layers) and statistical values such as averages, min., max. values from simulated sensor inputs.

Comparison Module & Logging

The comparison module of the test tool compares processed sensor data with data from the AWOS server (meteorological data and data telegrams to the ATC provider via proprietary back channel). Differences of the target/actual comparison are highlighted and displayed instantly. All inputs, outputs as well as relevant internal parameters are logged into a protocol file for later reference.

Eigenschaften

Name: WindSensorA line 11
 Beschreibung: At 05tdz
 Adresse: Offen
 Letzter Fehler: 11
 Port: 11
 Data: Gesendet: 5077, Zeit: 13.06.24, Empfangen: 0, Zeit:

Name	Gerät	Telegramm	Offset	Intervall
WindSensorA				
WindInst	WindSensorA	<01>WT1A 77 065 5F<13><10><03>	0,1	1
WindAvg	WindSensorA	<01>WALA 77 77 76 78 76 68 480 2400 061 051 071 061 0...	1,7	5
HKWind	WindSensorA	<01>HW1A +32.6 20.0 05.00 30.0 04.60 B4<13><10><03>	4,4	10
WindSensorB				
WindInst	WindSensorB	<01>WT1B 77 065 5F<13><10><03>	0,2	1
WindAvg	WindSensorB	<01>WALA 77 77 76 78 76 69 480 2400 061 051 071 061 0...	2,4	5
HKWind	WindSensorB	<01>HW1A +32.9 18.7 04.89 30.0 05.00 98<13><10><03>	4,3	10
WindSensorC				
WindInst	WindSensorC	<01>WT1B 76 059 5C<13><10><03>	0,2	1
WindAvg	WindSensorC	<01>WALB 77 77 76 78 76 66 480 2400 062 051 071 061 0...	1,3	5
HKWind	WindSensorC	<01>HW1B +31.5 19.4 04.56 30.0 04.61 9E<13><10><03>	7,3	10
WindSensorD				
WindInst	WindSensorD	<01>WT1B 77 054 60<13><10><03>	0,6	1
WindAvg	WindSensorD	<01>WALB 77 77 76 78 76 67 476 2396 061 051 071 061 0...	3,5	5
HKWind	WindSensorD	<01>HW1B +32.7 20.0 04.66 30.0 04.67 A0<13><10><03>	4,8	10
TempRHA				
TempRh	TempRHA	<01>TMLA +22.5 061.9 +14.8 +21.3 063.2 +14.0 36<13><10><03>	9,2	10
HKTempRh	TempRHA	<01>HT1A +27.7 01110 14.9 20.0 04.89 9C<13><10><03>	6,5	10

Log

```
Serial - RVRJ Visibility50+ line 41
21 15:06:06.338 <02>B4TA" 650 1933 -86383 6502 R0100 10 10 50 00 00 8B<13><10><04>
21 15:06:06.947 <02>B4TA" 650 1933 -86383 6502 R0100 10 10 50 00 00 8B<13><10><04>
21 15:06:07.541 <02>B4TA" 650 1933 -86383 6502 R0100 10 10 50 00 00 8B<13><10><04>
21 15:06:16.337 <02>B4TA" 650 1901 -86446 6548 R0100 10 10 50 00 00 86<13><10><04>
21 15:06:16.946 <02>B4TA" 650 1901 -86446 6548 R0100 10 10 50 00 00 86<13><10><04>
21 15:06:17.540 <02>B4TA" 650 1901 -86446 6548 R0100 10 10 50 00 00 86<13><10><04>
```

Fertig | Protokollierung Stopped | MetSim 1.0.19.0 | EDDH | CAP | NUM | SCR | 21.08.2012 13:06:24 UTC

Fig. 3: Telegram mode to display data telegrams as transmitted by the sensor interfaces.

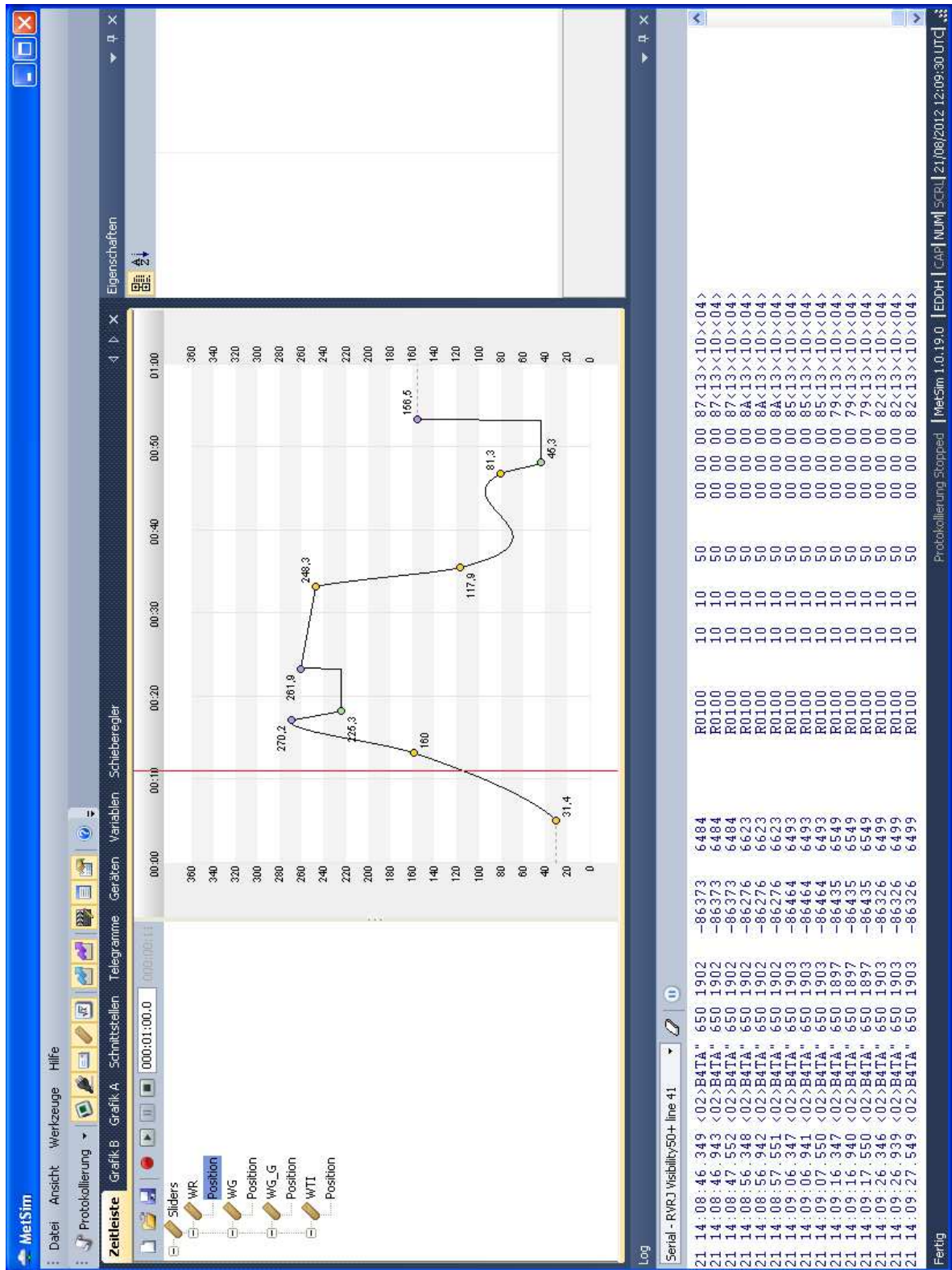


Fig. 4: Timeline to specify time response of a simulated sensor in an easy and intuitive way.

Metsim

Datei Ansicht Werkzeuge Hilfe
 Protokollierung Grafik A Schnittstellen Telegramme Geräten Variablen Schieberegler

Zuletzt: Grafik B Grafik A Schnittstellen Telegramme Geräten Variablen Schieberegler

Zeige Rowwert Zwingen

Name	Beschreibung	Gruppe	Station	Ausgegeben Wert	Gespiegelter Wert	XML Wert	Berechneter Wert
<input type="checkbox"/> DP_A1	1 min durchschnittliche Taupunkttemperatur, Se...	105sec	DWD5ensorData	13.8	13.7		
<input type="checkbox"/> DP_A2	1 min durchschnittliche Taupunkttemperatur, Se...	105sec	DWD5ensorData	13.7	13.7		
<input type="checkbox"/> DP_A	Instant-Taupunkt-Temperatur, Sensor A	105sec	EDDF	13.6	13.6		14.0
<input checked="" type="checkbox"/> DP_A1	Instant-Taupunkt-Temperatur, Sensor A (Haupt-)	105sec	DWD5ensorData	14	13.6		
<input type="checkbox"/> DP_A2	Instant-Taupunkt-Temperatur, Sensor A (Backup)	105sec	DWD5ensorData	13.9	13.6		
<input type="checkbox"/> InfoStatusV_A1	InfoStatus von Sichtbarkeit Sensor A (Haupt-)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_A2	InfoStatus von Sichtbarkeit Sensor A (Backup)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_B1	InfoStatus von Sichtbarkeit Sensor B (Haupt-)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_B2	InfoStatus von Sichtbarkeit Sensor B (Backup)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_C1	InfoStatus von Sichtbarkeit Sensor C (Haupt-)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_C2	InfoStatus von Sichtbarkeit Sensor C (Backup)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_E1	InfoStatus von Sichtweiten Sensor E (Haupt-)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_E2	InfoStatus von Sichtweiten Sensor E (Backup)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_F1	InfoStatus von Sichtbarkeit Sensor F (Haupt-)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_F2	InfoStatus von Sichtbarkeit Sensor F (Backup)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_G1	InfoStatus von Sichtbarkeit Sensor G (Haupt-)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_G2	InfoStatus von Sichtbarkeit Sensor G (Backup)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_I1	InfoStatus von Sichtbarkeit Sensor I (Haupt-)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_I2	InfoStatus von Sichtbarkeit Sensor I (Backup)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_K1	InfoStatus von Sichtbarkeit Sensor K (Haupt-)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_K2	InfoStatus von Sichtbarkeit Sensor K (Backup)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_L1	InfoStatus von Sichtbarkeit Sensor L (Haupt-)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_L2	InfoStatus von Sichtbarkeit Sensor L (Backup)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_M1	InfoStatus von Sichtbarkeit Sensor M (Haupt-)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_M2	InfoStatus von Sichtbarkeit Sensor M (Backup)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_N1	InfoStatus von Sichtbarkeit Sensor N (Haupt-)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_N2	InfoStatus von Sichtbarkeit Sensor N (Backup)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_O1	InfoStatus von Sichtbarkeit Sensor O (Haupt-)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_O2	InfoStatus von Sichtbarkeit Sensor O (Backup)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_P1	InfoStatus von Sichtbarkeit Sensor P (Haupt-)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> InfoStatusV_P2	InfoStatus von Sichtbarkeit Sensor P (Backup)	105sec	DWD5ensorData	-	-		///
<input type="checkbox"/> MOR_A	Sofortige meteorologische Sicht, Sensor A	105sec	EDDF	11003	11003		11003
<input type="checkbox"/> MOR_A1	Sofortige meteorologische Sicht, Sensor A (Hau...	105sec	DWD5ensorData	11000	11003		
<input type="checkbox"/> MOR_A2	Sofortige meteorologische Sicht, Sensor A (Back...	105sec	DWD5ensorData	11001	11001		
<input type="checkbox"/> MOR_B	Sofortige meteorologische Sicht, Sensor B	105sec	EDDF	10998	10998		11003
<input type="checkbox"/> MOR_B1	Sofortige meteorologische Sicht, Sensor B (Haupt-)	105sec	DWD5ensorData	11000	10998		
<input type="checkbox"/> MOR_B2	Sofortige meteorologische Sicht, Sensor B (Back...	105sec	DWD5ensorData	11002	11002		
<input type="checkbox"/> MOR_C	Sofortige meteorologische Sicht, Sensor C	105sec	EDDF	11000	11000		11000
<input type="checkbox"/> MOR_C1	Sofortige meteorologische Sicht, Sensor C (Hau...	105sec	DWD5ensorData	11003	11000		
<input type="checkbox"/> MOR_C2	Sofortige meteorologische Sicht, Sensor C (Back...	105sec	DWD5ensorData	10999	11003		
<input type="checkbox"/> MOR_E	Sofortige meteorologische Sicht, Sensor E	105sec	EDDF	10999	10998		10998
<input type="checkbox"/> MOR_E1	Sofortige meteorologische Sicht, Sensor E (Haupt-)	105sec	DWD5ensorData	10999	10998		
<input type="checkbox"/> MOR_E2	Sofortige meteorologische Sicht, Sensor E (Back...	105sec	DWD5ensorData	11002	10997		
<input type="checkbox"/> MOR_F	Sofortige meteorologische Sicht, Sensor F	105sec	EDDF	11002	11002		11002
<input type="checkbox"/> MOR_F1	Sofortige meteorologische Sicht, Sensor F (Haupt-)	105sec	DWD5ensorData	10999	11002		
<input type="checkbox"/> MOR_F2	Sofortige meteorologische Sicht, Sensor F (Back...	105sec	DWD5ensorData	11001	10998		
<input type="checkbox"/> MOR_G	Sofortige meteorologische Sicht, Sensor G	105sec	EDDF	11000	11000		10999
<input type="checkbox"/> MOR_G1	Sofortige meteorologische Sicht, Sensor G (Hau...	105sec	DWD5ensorData	10998	11000		
<input type="checkbox"/> MOR_G2	Sofortige meteorologische Sicht, Sensor G (Back...	105sec	DWD5ensorData	11000	11000		

Standard
 Name: DP_A1
 Beschreibung: Instant-Taupunkt-Temperatur, Se...
 Gruppe: 105sec
 Station: DWD5ensorData
 Sensorwerte:
 Ausgegeben Wert: 14
 Qualität von Sensor-Werte: OK
 Zeit: 09:22:58
 Gespiegelte Werte:
 Gespiegelter Wert: 13.9
 Qualität von gespiegelte ...: OK
 Zeit: 09:23:00
 XML Wert:
 XML Wert: UNKNOWN
 Qualität: UNKNOWN
 Berechnete Werte:
 Berechneter Wert:
 Qualität von Berechnete ...:
 Zeit:

Produktanwendung: Support
 ModEm 1.0.19.0 EDDF
 29/08/2012 09:23:38 UTC

Fig. 5: Variables view for target/actual comparison (comparison module).