BASIC DATA FEED PROTOCOL OVERVIEW

Confidential

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1   INTRODUCTION

The purpose of this document is to describe the data protocol for the Formula 1 timekeeping data available for the TATA Innovation Prize competition.

2   DATA PROTOCOL

The basic data provided in this protocol is organised into four "sheets" of information. Each sheet contains cells arranged into rows and columns with each cell having two attributes: a value and a colour.

Each time a client connects to the data feed, it should consider every cell of each sheet to be empty – a null-string `value` with a notional `colour` of `YELLOW`.

2.1 Message format

Each message in the protocol is transmitted in a text format; each line of text denoting a separate message. Each message is formatted into an XML fragment named `transaction` which in turn contains a single element called `data`.

There are two forms of this message: one used to convey cell contents and one to advertise the status of the data feeds.

2.1.1   Cell updates

The following example shows a single `transaction` message for a cell update:

```
<transaction identifier="101" messagecount="12345" timestamp="12:34:56.789">
   <data column="1" row="1" colour="YELLOW" value="1:23.456"/>
</transaction>
```

Note: the message has been broken into three lines purely to aid its legibility in this document. In the data feed itself it is unbroken and sent as a single line of text.

2.1.1.1   The **transaction** attributes

The `timestamp` attribute indicates time of day when the message was published.

The `messagecount` attribute provides debug and tracing information for the live data-publication system and is not considered significant with regards the timekeeping data itself.

The `identifier` attribute indicates the sheet that the cell update relates to. Expected values are 101, 102, 103 and 104.

2.1.1.2   The **data** attributes

The `column` and `row` attributes indicate the cell within the sheet that update relates to. Their values are positive integers.

The `colour` attribute indicates the new text colour for the cell. Expected values are: `WHITE`, `YELLOW`, `CYAN`, `GREEN`, `RED`, `PURPLE` and `GREY`.

The `value` attribute indicates the new text content for the cell. The format and range of values this can take varies depending upon the cell and as described in greater detail in the "sheet" sections of this document.

> Note: the protocol is considered "stateful", so when `data` messages only specify an update to one of a cell's attributes (for example, `value`), the other attribute (in this example, `colour`) is expected to retain its pre-existing state.

2.1.2   System status updates

The following example shows a single `transaction` message for a system status update:

```
<transaction identifier="101" messagecount="12345" timestamp="12:34:56.789">
   <data informationvalid="true" sessionstate="started"/>
</transaction>
```

Once again, the message is shown broken over three lines purely to aid its legibility.

The `identifier`, `timestamp` and `messagecount` attributes have the same format and meaning as they do for the cell update messages. However, status updates are not published for sheet `103`. It is sourced from the same system responsible sheet `101`, so status updates for sheet `101` should be applied to sheet `103` as well.

2.1.2.1   The **informationvalid** attribute

The `informationvalid` attribute indicates whether the cell data is suitable for publication. It takes a Boolean value: `true` or `false`. During a session it will normally be `true`. It will be `false` prior to each session until the timekeeping and associated systems are fully commissioned and return to `false` to allow them to be de-commissioned after a session. The value can also be `false` during a session should significant technical problems occur.

Immediately this value becomes `false`, each client application should hide any cell data it is publishing for the sheet or sheets in question. The data should remain hidden until this value is returned to `true`.

While the `informationvalid` attribute for a sheet is `false`, the client may continue to receive cell updates for it. It should process these internally as normal but not publish the results. This allows any necessary updates or corrections to be communicated to the client while the data is hidden so that the correct data can be consumed immediately the value returns to `true`.

2.1.2.2   The **sessionstate** attribute

The `sessionstate` attribute indicates the state of the session. It can take several values: `inactive`, `started`, `aborted`, `finished` and `finalised`. These are used in the following ways:

- Prior to the start of any session the system state will be `inactive`.

- While each session is progressing under green flag conditions, the session will be `started`.

- If a session is red-flagged, the session state will become `aborted`. It will remain in this state until the session resumes at which point the session state will return to `started`.

- When the chequered flag is shown, the session state will be `finished`.

- Once all data updates pertinent to the session have been published the state will be set to `finalised`. Clients of the live data feeds should use this transition to signal that it is safe to disconnect. Any cell update messages received following a `finalised` session state message should be ignored.

The `sessionstate` attribute relates to the session as a whole and not to any particular data set. Consequently, unnecessary duplication is avoided and it is only published for sheet `101`.

3 THE DATA SHEETS

The four data sheets in the protocol are numbered `101`, `102`, `103` and `104`. Each is used to hold a specific sub-set of data related to the current session.
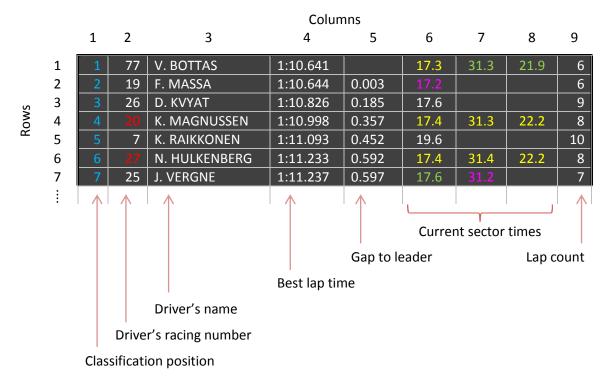
3.1 Sheet 101 - Classification

Sheet `101` depicts the current state of the classification for the session. It is updated each time a car crosses a timing line on the circuit. There are five such timing lines: the Control line, two Intermediate lines (at suitable positions approximately $\frac{1}{3}$ and $\frac{2}{3}$ of the way into each lap), one at the entry to the pit-lane and one at its exit.

The layout of sheet `101` is dependent upon the type of session being undertaken – practice, qualifying or the race – however these layouts are all broadly similar.

3.1.1 Practice session format

During the practice sessions (P1, P2 and P3), sheet `101` is laid out as depicted below with each row relating to a single driver:

Columns

	1	2	3	4	5	6	7	8	9
1	1	77	V. BOTTAS	1:10.641		17.3	31.3	21.9	6
2	2	19	F. MASSA	1:10.644	0.003	17.2			6
3	3	26	D. KVYAT	1:10.826	0.185	17.6			9
4	4	20	K. MAGNUSSEN	1:10.998	0.357	17.4	31.3	22.2	8
5	5	7	K. RAIKKONEN	1:11.093	0.452	19.6			10
6	6	27	N. HULKENBERG	1:11.233	0.592	17.4	31.4	22.2	8
7	7	25	J. VERGNE	1:11.237	0.597	17.6	31.2		7

Rows

Current sector times

Gap to leader

Lap count

Best lap time

Driver's name

Driver's racing number

Classification position

3.1.1.1   Classification position

The driver's classification position is shown in column 1 in `CYAN`.

3.1.1.2   Racing number

The driver's racing number is shown in column 2. Whenever a driver is in the pit-lane, the number will be shown in `RED`. When he is on track, his racing number will be `WHITE`.

3.1.1.3   Driver name

The driver's name is shown in column 3 in `WHITE`.

3.1.1.4   Lap time

The best lap time recorded by the driver in the session is shown in column 4 in `WHITE`.

3.1.1.5   Gap to leader

The time difference between the driver's best lap time and the overall best lap time is shown in column 5 in `WHITE`. The value for the driver in position 1 would always be zero and is left blank.

3.1.1.6   Sector times

When a driver passes the Intermediate 1 timing point on track (approximately $\frac{1}{3}$ of the way round the lap) his Sector 1 time (the time from the Control line to Intermediate 1) will be shown in column 6:

	Columns	
6	7	8

Row 1 | 17.2 | | |

When he reaches the Intermediate 2 line (approximately $\frac{2}{3}$ lap distance), his Sector 2 time (the time from Intermediates 1 to 2) will be shown in column 7:

| 17.2 | 30.3 | |

When he reaches the Control line to complete his "flying lap", his Sector 3 time (from Intermediate 2 to the Control line) will be shown in column 8:

| 17.2 | 30.3 | 21.9 |

These times will remain displayed until he reaches Intermediate 1 again at which point his new Sector 1 time will be shown in column 6 and the values in columns 7 and 8 will be cleared.

| 18.9 | | |

Sector times will normally be coloured `YELLOW`, with the driver's most recent sector time shown in `WHITE`. However, when a driver records his fastest time in a sector, other colours are used to highlight the performance: `GREEN` indicates it is his personal best time and `PURPLE` the best time by anyone in the session.

When the driver returns to the pits, columns 6 to 8 change to show the fastest sector times he has achieved in the session so far. In this case, the times are always shown in `YELLOW` - so as not to distract from the times being set by cars on track.

17.3	31.3	21.9

If any sector time exceeds 99.9 seconds, it will not be shown and the relevant cell will be blanked instead.

3.1.1.7   Stopped on track

Whenever a driver stops on track (or travels abnormally slowly) the word `STOP` will be shown in `YELLOW` in the cell for the respective sector. For example:
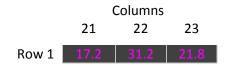
STOP			For drivers stopped in Sector 1

17.2	STOP		For drivers stopped in Sector 2

17.2	30.3	STOP	For drivers stopped in Sector 3

3.1.1.8   Lap count

The number of laps that each driver has started in the session is shown in column 9 in `WHITE`.

3.1.1.9   Best sector times

In addition to the cells already indicated, the cells in columns 21, 22 and 23 of row 1 are used to indicate the best sector times recorded by any driver in the session. Column 21 indicates the best performance for Sector 1, column 22 the best performance in Sector 2 and column 23, sector 3.

Columns

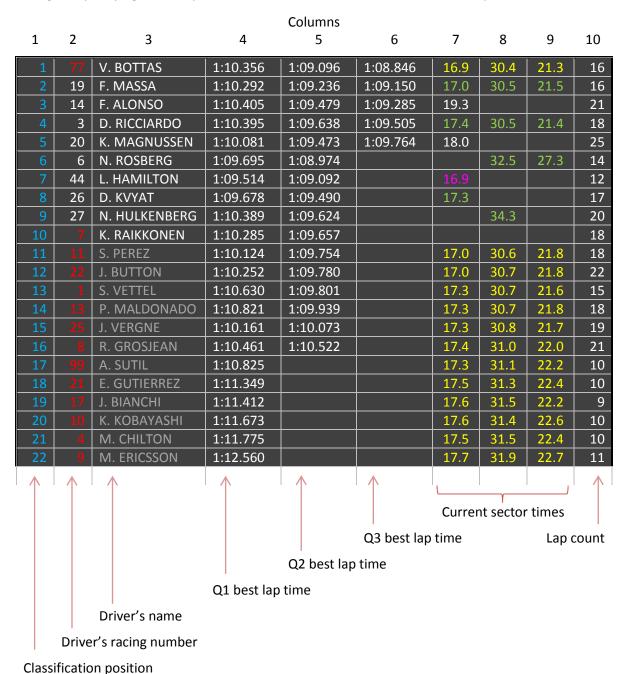|	21	22	23
Row 1	17.2	31.2	21.8

These values alternate every few seconds between the sector times (shown to one decimal place) and the official three-letter abbreviation for the driver.

MAS	VER	MAS

3.1.2 Qualifying session format

During the qualifying session (parts Q1, Q2 and Q3), sheet `101` is laid out as depicted below:

Columns

1	2	3	4	5	6	7	8	9	10
1	77	V. BOTTAS	1:10.356	1:09.096	1:08.846	16.9	30.4	21.3	16
2	19	F. MASSA	1:10.292	1:09.236	1:09.150	17.0	30.5	21.5	16
3	14	F. ALONSO	1:10.405	1:09.479	1:09.285	19.3			21
4	3	D. RICCIARDO	1:10.395	1:09.638	1:09.505	17.4	30.5	21.4	18
5	20	K. MAGNUSSEN	1:10.081	1:09.473	1:09.764	18.0			25
6	6	N. ROSBERG	1:09.695	1:08.974			32.5	27.3	14
7	44	L. HAMILTON	1:09.514	1:09.092		16.9			12
8	26	D. KVYAT	1:09.678	1:09.490		17.3			17
9	27	N. HULKENBERG	1:10.389	1:09.624			34.3		20
10	7	K. RAIKKONEN	1:10.285	1:09.657					18
11	11	S. PEREZ	1:10.124	1:09.754		17.0	30.6	21.8	18
12	22	J. BUTTON	1:10.252	1:09.780		17.0	30.7	21.8	22
13	1	S. VETTEL	1:10.630	1:09.801		17.3	30.7	21.6	15
14	13	P. MALDONADO	1:10.821	1:09.939		17.3	30.7	21.8	18
15	25	J. VERGNE	1:10.161	1:10.073		17.3	30.8	21.7	19
16	8	R. GROSJEAN	1:10.461	1:10.522		17.4	31.0	22.0	21
17	99	A. SUTIL	1:10.825			17.3	31.1	22.2	10
18	21	E. GUTIERREZ	1:11.349			17.5	31.3	22.4	10
19	17	J. BIANCHI	1:11.412			17.6	31.5	22.2	9
20	10	K. KOBAYASHI	1:11.673			17.6	31.4	22.6	10
21	4	M. CHILTON	1:11.775			17.5	31.5	22.4	10
22	9	M. ERICSSON	1:12.560			17.7	31.9	22.7	11

Current sector times

Q3 best lap time

Lap count

Q2 best lap time

Q1 best lap time

Driver's name

Driver's racing number

Classification position

3.1.2.1 Classification position

If a driver has not done enough according to the rules to be classified in the session, his classification position (column 1 `value`) will be blank.

3.1.2.2 Racing number

Just as for the Practice layout, whenever a driver is in the pit-lane his racing number is shown in `RED`. When he is on track, his racing number is `WHITE`.

3.1.2.3   Driver names

The names of the drivers ineligible to compete in the current part of qualifying – due to not having set a fast enough time in a previous part of qualifying – are shown in `GREY`.

Those eligible to take part, but who have not yet done enough according to the rules to be classified in the session are shown in `YELLOW`. The rest – those eligible to take part that are satisfying the current qualifying criteria – are shown in `WHITE`.

3.1.2.4   Lap times

The best lap times recorded by each driver in each of the three parts of the qualifying session are shown in columns 4, 5 and 6 in `WHITE`. The best lap time for Q1 is shown in column 4, the best lap time for Q2 is shown in column 5 and the best Q3 time in column 6. If a driver has not set a time, the relevant cell will remain blank.

3.1.2.5   Sector times and stopped cars

The sector times (in columns 7, 8 and 9) are updated as drivers record new sector times or stop on track in the same manner as they are for the Practice layout.

3.1.2.6   Lap count

The number of laps that each driver has started in the session as a whole is shown in column 10 in `WHITE`.

3.1.2.7   Best sector times

As for the practice session, columns 21, 22 and 23 of row 1 are used to depict the fastest sector times recorded in the session as a whole. Again, these values alternate between the sector time and the three-letter abbreviated name of the driver that set the time.

3.1.2.8   Qualifying criteria

In addition to the cells already indicated, the cell in column 41 of row 1 is used to indicate the cut-off criteria for qualifying. Under the current regulations this value is 107% of the fastest lap time set in the first part of qualifying (Q1).

Before any lap times are recorded in Q1, this value is blank. Once a lap time has been recorded this value is populated and shown in `CYAN`. It will be updated every time the fastest lap in Q1 changes.
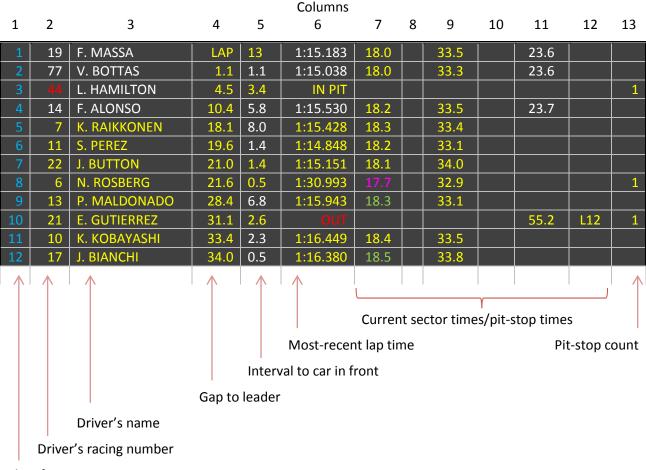
Column
41

Row 1   1:14.379

3.1.3   Race session format

During races, sheet `101` is laid out as depicted below:

Columns

1	2	3	4	5	6	7	8	9	10	11	12	13
1	19	F. MASSA	LAP	13	1:15.183	18.0		33.5		23.6		
2	77	V. BOTTAS	1.1	1.1	1:15.038	18.0		33.3		23.6		
3	44	L. HAMILTON	4.5	3.4	IN PIT							1
4	14	F. ALONSO	10.4	5.8	1:15.530	18.2		33.5		23.7		
5	7	K. RAIKKONEN	18.1	8.0	1:15.428	18.3		33.4				
6	11	S. PEREZ	19.6	1.4	1:14.848	18.2		33.1				
7	22	J. BUTTON	21.0	1.4	1:15.151	18.1		34.0				
8	6	N. ROSBERG	21.6	0.5	1:30.993	17.7		32.9				1
9	13	P. MALDONADO	28.4	6.8	1:15.943	18.3		33.1				
10	21	E. GUTIERREZ	31.1	2.6	OUT					55.2	L12	1
11	10	K. KOBAYASHI	33.4	2.3	1:16.449	18.4		33.5				
12	17	J. BIANCHI	34.0	0.5	1:16.380	18.5		33.8				

Current sector times/pit-stop times

Most-recent lap time   Pit-stop count

Interval to car in front

Gap to leader

Driver's name

Driver's racing number

Classification position

3.1.3.1   Classification position

If a driver has not done enough according to the rules to be classified in the race, his classification position (column 1 `value`) will be blank.

3.1.3.2   Racing number

Just as in the other sessions, whenever a driver is in the pit-lane his racing number is shown in `RED`. When he is on track, his racing number is `WHITE`. However, unlike the other sessions, if the driver's most-recent lap if the current fastest race lap the number will be shown in `PURPLE`.

3.1.3.3   Driver names

Like the racing number, whenever a driver sets the fastest lap in the race, his name is shown in `PURPLE` for the duration of the following lap (or until another driver betters the time whichever is the sooner).

More usually, the race leader and drivers that have crossed the Control line more recently than him are shown in `WHITE` with all other driver names shown in `YELLOW`.

3.1.3.4　　Gap to leader

This column shows how far the driver was behind the leader the last time he crossed the Control line. If the driver was on the same lap as the leader, a time difference will be shown to one decimal place. However, should the gap be greater than 99.9 seconds, the cell will remain blank. If the driver is one lap or more behind the leader the lap count difference will be shown suffixed by the letter "L" (e.g. `1L`, `2L`, etc.).

The value for the leader himself will be the word "LAP". It is intended to be read in conjunction with the value in cell 5 to indicate the current race lap.

All of these values are shown in `YELLOW`.

3.1.3.5　　Interval to car in-front

This column shows how far the driver was behind the next car up in the classification the last time he crossed the Control line. This is not necessarily the car directly ahead of him on the track as that may be a lapped car. Just as in column 4, this can be a time difference or a lap count; however, unlike column 4, the colour can vary. `WHITE` will be used if the value represents an improvement upon his previous value (i.e. if he is catching the car ahead of him) and `YELLOW` if it does not.

The value for the leader himself will be the number of laps he has completed in the race and is always shown in `YELLOW`.

3.1.3.6　　Lap time

This column shows the lap time the driver recorded for his most recently completed lap. While the driver is in Sector 1 the new lap time will be shown in `WHITE` unless it is a fastest lap. In these cases, it will be `GREEN` if it's the driver's personal fastest lap and `PURPLE` if it's the overall fastest.

When the driver is on track in Sectors 2 and 3, the time will be shown in `YELLOW`.

If the driver enters the pit-lane, the lap time is replaced by the text "`IN PIT`" shown in `RED`. The text remains for the duration of the pit-stop; however, after a short period its colour reverts to `YELLOW`.

Similarly, when the driver leaves the pit-lane, the text is changed to "`OUT`" until he next crosses the Control line. While he is in Sector 1, "`OUT`" will be shown in `RED` and when in Sectors 2 and 3 it will be `YELLOW`.

If the driver retires from the race in the pits (or takes an excessively long time for a pit-stop) the text is replaced with the word `RETIRED` in `YELLOW`
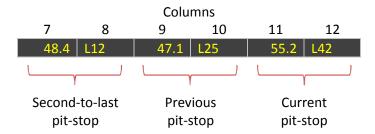
3.1.3.7　　Sector times and stopped cars

While drivers are on track, the sector times (in columns 7, 9 and 11) are updated as the drivers record new sector times or stop on track in the same manner as in the other sessions. The values in columns 8, 10 and 12 are always blank.

However, when drivers enter the pit-lane, the sector times are removed from display and the driver's three most recent pit-stop times are shown. Columns 11 and 12 show the details for the pit-stop the driver is undertaking. The total time he spends in the pit-lane (between the pit-entry and pit-exit timing lines) is shown in column 11 and the lap number on which he is stopping in column

12. This data starts off blank when the car enters the pit-lane and is populated as he completed his pit-stop.

Columns 9 & 10 and 7 & 8 show the equivalent data for the driver's two previous pit-stops respectively – one or both will be blank if the driver has yet to undertake three pit-stops in the race.

Columns

7	8	9	10	11	12
48.4	L12	47.1	L25	55.2	L42

Second-to-last pit-stop Previous pit-stop Current pit-stop

These times and lap indicators are always shown in `YELLOW` and remain on the screen until the driver reaches the Intermediate 1 timing line after exiting the pit-lane.

3.1.3.8   Pit-stop count

Column 13 shows the number of times the car has travelled through the pit-lane; whether doing so to complete a pit-stop or a drive-through or stop-go penalty. This value is always shown in `YELLOW`.

3.2   SHEET 102 – Speeds & Locations

Sheet `102` depicts the top-six entries for four separate classifications – one for each speed-recording location on the circuit – and indicates the number of cars participating in the session.
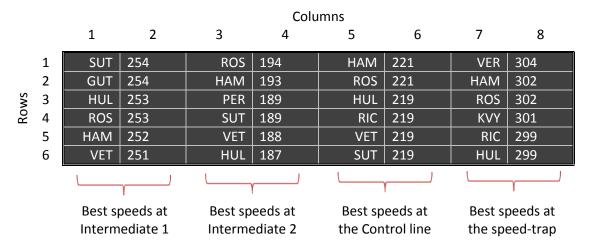
Once again, the layout of sheet `102` is dependent upon the type of session being undertaken – practice, qualifying or the race – however these layouts are all broadly similar.

3.2.1   Practice and Qualifying session format

During all of the practice sessions (P1, P2 and P3) and the qualifying session (parts Q1, Q2 and Q3), sheet `102` has the same format.

3.2.1.1   Speed classifications

The first eight columns of are used to depict the speed classifications as laid out below:

Columns

Rows	1	2	3	4	5	6	7	8
1	SUT	254	ROS	194	HAM	221	VER	304
2	GUT	254	HAM	193	ROS	221	HAM	302
3	HUL	253	PER	189	HUL	219	ROS	302
4	ROS	253	SUT	189	RIC	219	KVY	301
5	HAM	252	VET	188	VET	219	RIC	299
6	VET	251	HUL	187	SUT	219	HUL	299

Best speeds at Intermediate 1   Best speeds at Intermediate 2   Best speeds at the Control line   Best speeds at the speed-trap

Row 1 holds the data for position 1 in each classification, row 2 holds position 2, and so on.
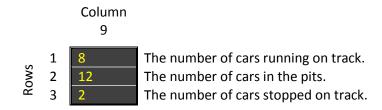
Columns 1 & 2 contain the top six entries of the classification for fastest speed recorded at the Intermediate 1 line. The three-letter abbreviated name of the driver is shown in column 1, with the fastest time he recorded in column 2. The speeds are shown in integer values measured in kilometres-per-hour.

Columns 3 & 4 show a similar classification based upon the fastest speeds recorded at the Intermediate 2 line; columns 5 & 6 the same for the Control line and column 7 & 8 the same for the speed-trap. The speed-trap is a specially selected point of the circuit at which useful or interesting speed information may be recorded. This is often the fastest part of the circuit, but in cases in which this is already the location of one of the other timing lines another interesting location is selected.

All cells are coloured `WHITE`.

3.2.1.2   Car locations

Column 9 of sheet 102 is used to convey generalised location and state information for the cars as a whole.

Column
9

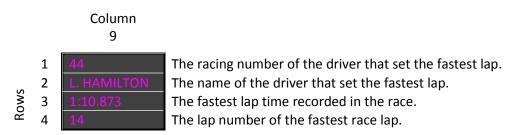|		
1	8	The number of cars running on track.
2	12	The number of cars in the pits.
3	2	The number of cars stopped on track.

Rows

These values are updated during the session as necessary whenever a car enters or leaves the pit-lane or stops on track. The values are all depicted in `YELLOW`.

3.2.2   Race session format

During races, sheet `102` follows a similar format to that used for the other sessions. The only difference relates to use of column 9.

3.2.2.1   Fastest lap

During races, column 9 holds information relating to the fastest lap of the race.
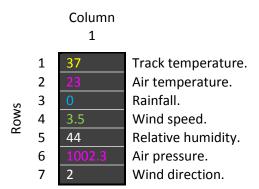
Column
9

1	44	The racing number of the driver that set the fastest lap.
2	L. HAMILTON	The name of the driver that set the fastest lap.
3	1:10.873	The fastest lap time recorded in the race.
4	14	The lap number of the fastest race lap.

Rows

These values are updated every time a new fastest lap of the race is recorded and all the values are shown in `PURPLE`.

3.3 SHEET 103 – Weather & Session time

Sheet `103` holds the current meteorological readings as well as the official time remain clock for the session. It has the same layout for all sessions.

3.3.1.1 Weather data

Column 1 of sheet `103` holds the weather data. The weather data is updated once per minute and is laid out as follows:

Column 1

Rows		
1	37	Track temperature.
2	23	Air temperature.
3	0	Rainfall.
4	3.5	Wind speed.
5	44	Relative humidity.
6	1002.3	Air pressure.
7	2	Wind direction.

3.3.1.2 Track and air temperatures

Row 1 of column 1 holds the current track temperature, and row 2 holds the corresponding air temperature. Both readings are measured in degrees Celsius. The track temperature is shown in `YELLOW` and the air temperature in `PURPLE`.

3.3.1.3 Rainfall

Row 3 holds the rain fall indicator. A value of 1 indicates it is currently raining, a value of 0 indicates it is not. The rainfall value is depicted in `CYAN`.

3.3.1.4 Wind speed and direction

The current wind speed is given in row 4. It is shown in GREEN, to one decimal place in units of metres per second. The current wind direction is shown in row 7. It is measured in degrees clockwise from North (i.e. 0° represents North). The wind direction is always shown in `WHITE`.

3.3.1.5 Relative humidity

Row 5 holds the current relative humidity prevailing at the circuit. It is reported as an integer percentage and presented coloured `WHITE`.

3.3.1.6 Air pressure

The current barometric pressure value is held in row 6 and coloured `PURPLE`. It is measured in milli-Bars and reported to one decimal place.

3.3.1.7   Session time remaining

The cell in row 1 of column 2 of sheet `103` holds the official record or the time remaining in the current session:

Column 2

Row 1   `1:34:23`

It automatically updates as necessary according to the rules when the session starts. It is always reported to an accuracy of one second and always depicted in `YELLOW`.

Note: the session is not necessarily over when this time reaches zero. The `sessionstate` attribute associated with sheet `101` should always be used to determine when a chequered flag is shown.

3.4   SHEET 104 – Session identity & Track status

Unlike the other sheets, sheet `104` does not hold any cell data. Instead some additional attributes are associated with it which are used to identify the current session and the prevailing track status.

The following example shows a single `transaction` message with these attributes:

```
<transaction identifier="104" messagecount="12345" timestamp="12:34:56.789">
   <data trackstatus="1" sessionid="4" sessionpart="1"/>
</transaction>
```

Again, the message is shown broken over three lines purely to aid its legibility.

3.4.1.1   The `trackstatus` attribute

The `trackstatus` attribute holds an integer value indicating the current track state. It can take a value from 1 to 5, each having the following meaning:

`trackstatus` value	Track status
1	Normal – there are no incidents on track.
2	Incident – there are yellow flags being shown around the circuit.
3	Safety-Car on stand-by – an incident has occurred and the Safety-Car has been alerted while assessment takes place in case it is needed.
4	Safety-Car deployed – an incident has occurred requiring the Safety-Car to set the pace for the cars on the track.
5	Red flag – the session has been suspended to deal with a major incident.

3.4.1.2   The `sessionid` attribute

The `sessionid` attribute indicates the session being run. It takes an integer value according to the following table:

`sessionid` value	Session
2	First practice session.
3	Second practice session.
12	Third practice session.
4	Qualifying.
14	Race.

3.4.1.3   The `sessionpart` attribute

The `sessionpart` attribute is only valid for the qualifying session (`sessionid` 4) and takes an integer value according to the following table:

`sessionpart` value	Qualifying part
1	Part 1 of qualifying (Q1).
2	Part 2 of qualifying (Q2).
3	Part 3 of qualifying (Q3).