Aplicom®

# APLICOM A9 COMPACT TRACKING UNIT W/SW

## A9

## Product Description

## Rev 1.1.0

Order code K520100

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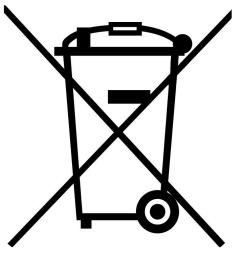

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# REVISION HISTORY

| Rev. | Date | Editor | Description |
|---|---|---|---|
| 1.1.0 | 15.1.2014 | JSa | A9 options updated |
| 1.0.2 | 4.4.2013 | AMu | Minor changes to the text |
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# 1 INTRODUCTION

## 1.1 What is Aplicom A9

A9 is a compact vehicle computer unit with a readymade easily configurable software for vehicle fleet and other GPS tracking and security purposes. A9, equipped with over the air (OTA) management capabilities and multiple interfaces to various additional devices in the vehicle, like iButton, driver log keypad, RFID readers and temperature sensors, provides a powerful combination for making tracking and tracing systems easy and flexible. A9 can be used for example as electronic driver logbook and in security applications as well as when remotely monitoring the mobile assets. Open communication protocol and standard GPRS communications together with few simple messages introduced, makes the integration to back-end systems straightforward and easy.

The A9 is ready to use after configuring it. The configuring is necessary because each GPRS network has its own communications settings and also end-customer needs for tracking functions are varying case by case.

Aplicom A9 is continued development of Aplicom A1 products. The product families have largely the same features and share many specifications as well as well proven SW core. The customer benefit is to be able to use similarly reliable A9 product with the same backend systems as A1 since the used protocols, configuration tools and principles are the same for both product families. A9 is more compact in design and has subset of A1 interfaces. A9 product will be further developed with future SW options enabling expanding use of new modular features that will be introduced by Aplicom.

## 1.2 What is Aplicom A9 GLONASS

A9 GLONASS is a same device as A9 but additional to GPS receiver it also has GLONASS positioning capability. This adds more accuracy for positioning with higher number of satellites in calculation. The product is mainly targeted for use in markets requiring GLONASS capability. Later in this document A9 features are also A9 GLONASS features if not specifically differentiated.


Figure 1 A9 unit

## 1.3 Purpose of this document

This document gives an overview of the functionality and characteristics of the Aplicom A9 product. Latest features of A9 SW 1.0 release are included in this document.

## 1.4 Intended audience

Technical management personnel and system designers responsible of specifying total fleet or asset management system.

## 1.5 Further reading

When starting system development with Aplicom A9 units, make sure that you have thoroughly read and understood this document. For deeper understanding, please refer to the following documents:

- **K520050** *A9 SW User Manual*: this document describes in more detail the different features of A9.
- **K503021** *Aplicom A1 SW Configurator User Manual*: this document explains the features and the use of SW Configurator.
- **K503051** *A1 Track SW Configuration OTA Update Manual*: this document describes the Over-The-Air update procedure of Aplicom A9 SW Configuration.
- **K520001** *A9 Installation Guide*: this document explains how the physical installation of A9 units to vehicles or other assembly place is done. The installation guide is delivered with each A9 unit shipment.
- **S100300** *Aplicom D-protocol* specification describes used D-protocol.
- **S100301** *Aplicom T-protocol* specification describes used T-protocol.
- **S100302** *Aplicom F protocol specification* describes FMS CAN data reporting protocol
- **S100340** Aplicom Reliable protocol Specification
- **K503113** *A1 Garmin SW IF product description* ( A9 uses the same protocol as A1)

# 2 SYSTEM DESCRIPTION OF A9

Typical example of a total tracking system built with A9 would consist of a server, a communication gateway through the Internet using GPRS and several A9 units.

The server must be equipped with an Internet connection with a static IP address and an open port. The server has a communication handler, which handles data received from A9 units through Internet. It also typically has a software which is able to handle and convert data from A9 units and database, where received data is stored for real-time viewing on a map and/or for later analysis. Possible applications on the server side include (but are not limited to) tracing, reporting and reviewing vehicles routes. Other events like IO actions and geofence information can be stored for collecting vehicles route history containing all the information that can be used to trigger alarms and perform additional tasks according to end-user's demands. This end user application is in many cases accessed through internet/extranet as a service for wider user groups.

Aplicom is not a supplier of the tracking server components. Server applications must be developed by the customer or selected software partner. Aplicom can provide technical assistance regarding the functionality of A9 Tracking to ease the development work.

Aplicom however offers Quick Start Service with web portal access for quick start up to familiarise A9 product.

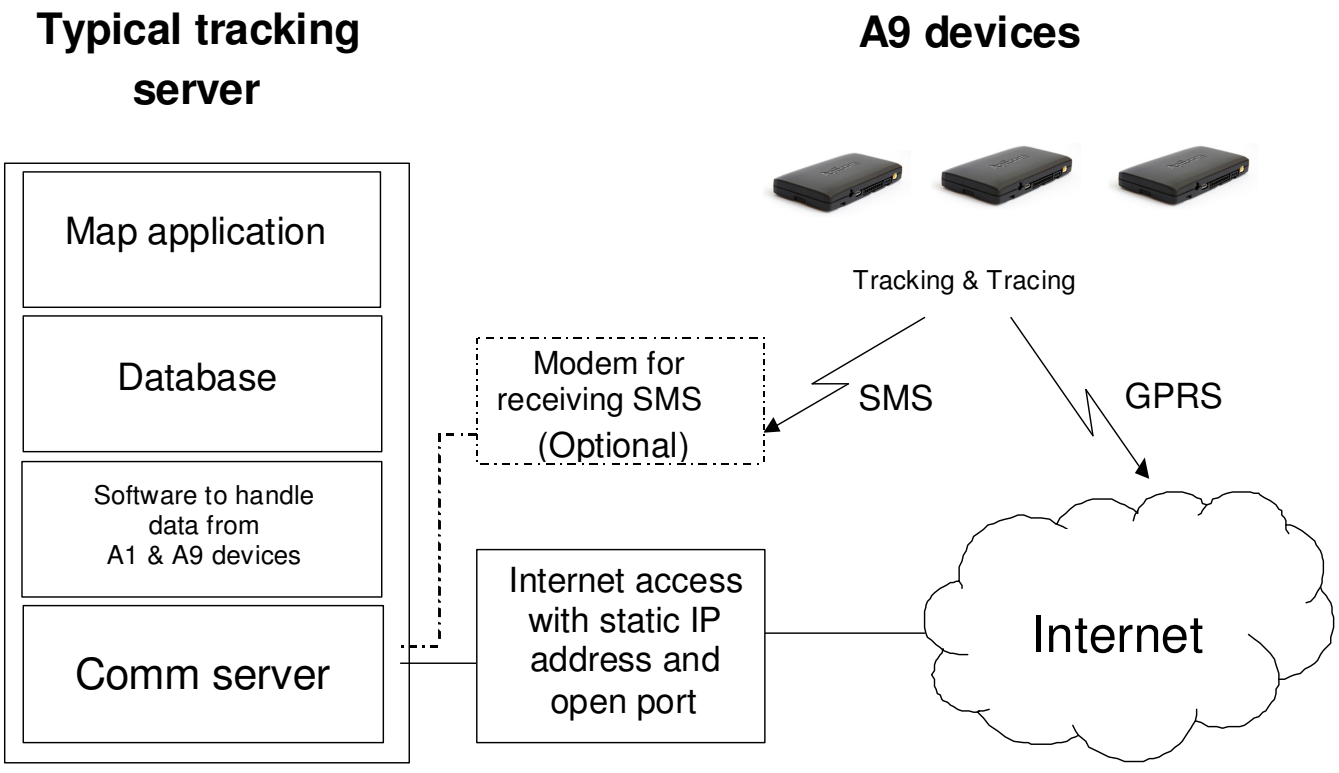



Figure 2 Example of typical system architecture

# 3 FEATURES OF A9

This section describes the features of A9.

## 3.1 Main features of A9

A9 unit includes factory installed tracking and tracing software.

A9 is a fully configurable tracking unit. It is possible to make tracking solutions for most demanding customer cases. It's fully configurable, event to action based functionality, together with user set parameters makes it adaptable to various operational needs. Also the A9 supported connectivity adds many new possibilities to use the unit in different kind of applications.

The A9 main function is to send event based snapshots to server(s) according to defined configuration.

Fully configurable event to action based operation with optional conditional execution (AND, OR, IF operators).

Quick steps for first use with simple local settings (also with SMS message) and ready made default configuration for tracking and tracing.

Sending of event based snapshots to server according to configuration

Events: Time interval, Distance, Geofence, Start/Stop moving, Direction change, Driver-ID read, IGN on/off, Speed limit, Battery low, Alarm active, Input/Output changed , heading change, A/D threshold, Comm fail, flag changed, GLONASS/GPS status changed, data event from incoming SMS or TCP message, net changed, scheduled event, harsh braking, acceleration limit, accident etc.

Accurate GPS (and GLONASS in A9 GLONASS) position based distance calculation.

Open protocols for server connectivity with optional security and certificates (same as in Aplicom A1): Bearers: GPRS: TCP/UDP, SMS.

A9 offers open protocols for server connectivity. Supported bearers are GPRS and SMS. Possible protocols include TCP/UDP. Data protocol report size is optimised for saving transmission costs and has selectable contents.

Different protocols are supported:
- D : (Data) for sending snapshot data in binary data format.
- TC : (Text Compact) for sending snapshot data in a compact CSV compatible format.
- TV : (Text Verbose) for sending snapshot data in human-readable, plain text format.

D protocol has support for selectable data fields and full IMEI transmit as unit ID, making unit identification easy and data communication optimal. Backwards compatibility is ensured by supporting also 1.0 version of the protocol.

Optional ACK/NACK functionality (R-protocol) is available for additional reliability for data communications, ensuring the lossless end to end data transfer over TCP/IP if basic TCP reliability level is not enough.

GPRS data communication can be encrypted using SSL over TCP/IP. Authentication is optionally supported with certificates.

Messages (snapshots) can be concatenated, i.e. send several snapshots in one TCP connection, thus further reducing the overhead.

The priority of the messages is also configurable. Messages can also be configured to be saved into nonvolatile memory.

While roaming outside of the home network, unit functionality can be controlled with configuring for example so, that non-critical reporting can be prevented and reports can be stored to internal memory, or so that no messages will be sent during roaming. Additionally A9 software offers a possibility to create LAI listing (Location Area Identification) for approved networks. Also this listing can be turned to a "black list" of unwanted network LAI codes just by selecting one parameter differently. Software determines according to this LAI listing, if unit communicates in current network or not.

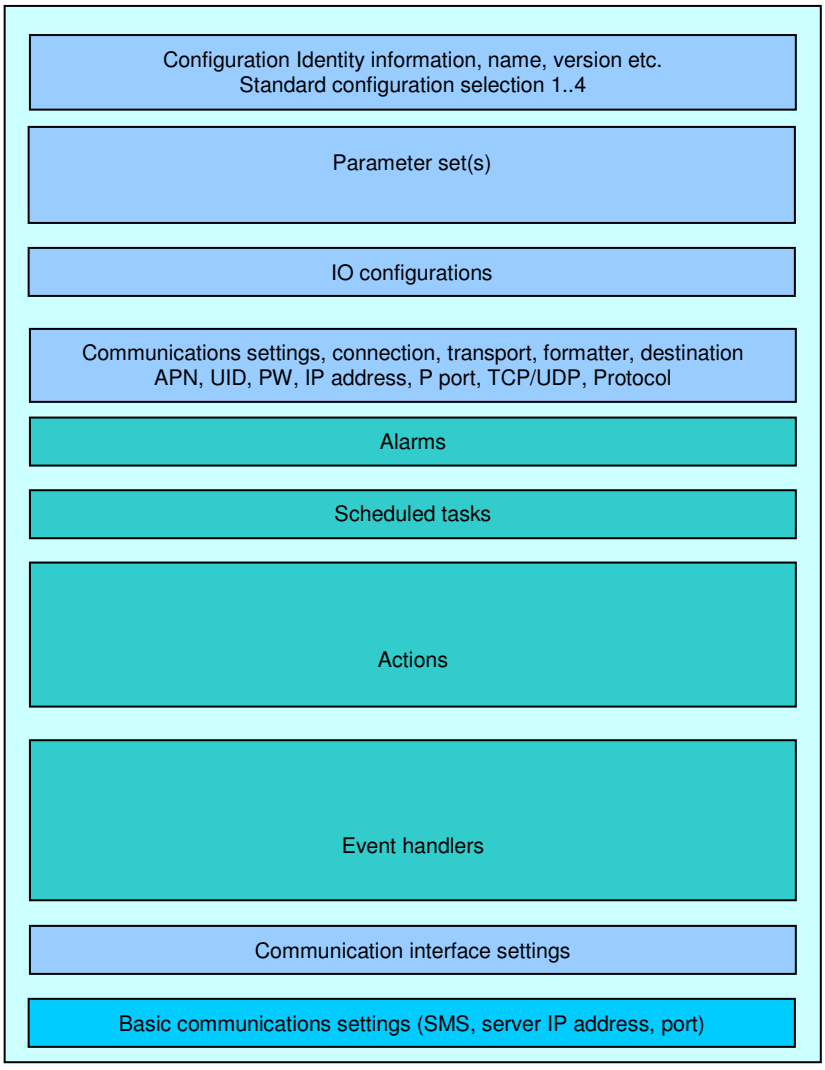
Also available are power source detection, internal full operation back-up battery and timed wake-up - positioning – sleep capability.

A9 Software and its configuration can be updated using OTA mechanisms.

A9 configuration contains following main sections in a xml file that is either embedded in the application jar file or separately downloaded file to A9 unit.

In one jar file there can be several configurations that can be switched on during operation by A9 configuration defined action or activated externally for example by server command or SMS message. Also several configurations can be loaded to A9 unit file system as xml files and switched to use similarly from A9 configuration or with external commands.

The principal default structure of the A9 configuration xml file (also generated and downloaded by A1 Configurator) is:




*A9 configuration xml file structure*

In next chapters there are general descriptions of different configuration items that are available.

For detailed and complete information about all features and possibilities of configuring the unit, please refer to documents *K520050 A9 SW user manual* and *K503021 Aplicom A1 SW Configurator User Manual*. This also includes support for configuring A9 SW functions.

## 3.2 Parameters

A9 uses configurable parameter sets to set current working settings and behaviour of various services of A9. It is possible to change active parameter set as an action according to used configuration. This way the unit can adapt to different situations flexibly for example to save communications cost while roaming etc.

Parameters in parameter sets are as follows:

| | |
|---|---|
| GPSReadInterval_s | Defines how often position information should be updated. |
| DistanceBetweenEvents_m | Defines how many meters must be traveled before a DISTANCE_TRAVELED event is generated. |
| DirectionChangeAngle_deg | Defines angle threshold for direction change check. |
| DirectionChangeTimeWindow_s | Defines time window for direction change check. |
| SpeedLimit_kmh | Defines velocity threshold for speed limit check. |
| MovingCheckTimeWindow_s | Defines time window for moving/stopped check. |
| MovingCheckDistance_m | Defines distance threshold for moving/stopped check. |
| CommunicationThreshold_pri | Sets priority threshold for communication. Only transports with priority lower than or equal to the threshold are allowed to send messages when the parameter set is active. |
| AliveMessageInterval_s | Defines time between ALIVE messages. |
| AliveMessageTransportId_txt | Defines which transport should be used to send the ALIVE messages. |
| PowerOffDelay_s | Defines time to wait after IGN_OFF event before powering down the device. |
| Power off mode | Defines power down mode, Power down, Sleep mode, OTAP mode. |
| Wake-up reasons | Defines alternative wake-up reasons, from power down and sleep modes. |
| Wake-up time | Defines unit wake up time from entering to power down or sleep mode. |
| CommunicationFailEventTimeout_s | Defines when COMM_FAIL event will be released after communication failure. |
| CommunicationFailReattachTimeout_s | Defines when GPRS reattach is tried after communication failure. |
| Harsh_Braking_Limit_kmh_s | Defines harsh braking limit as deceleration (km/h in seconds). |
| Acceleration_Limit_kmh_s | Defines acceleration limit as acceleration (km/h in seconds). |

## 3.3 IO Configurations

A9 uses configurable IO parameters to set current working settings and behaviour of available IO's. The IO configuration settings define how the application gets the related IO information and how to use the IO.

IO Configurations are as follows:

| | |
|---|---|
| AD poll interval | Defines how often actual AD converter data is read. |
| AD threshold definitions | AD thresholds that generate events, max. 4 different levels per AD input. |
| Main power threshold | Voltage thresholds that generate events of unit external power input voltage levels. |
| Input flag change time | Defines time how long the input must be stable before equalling IO flag is set. |
| Output mode setting | Defines output setting, OC (open collector), Dout (3V active HIGH) for LED drive etc. |
| Driver Log Keypad | Defines DLKP and 3PAD and combined use with iButton, operation modes. |
| Power down configuration | Defines if IGN is used to start the unit or IGN is not used. |
| Pulsecounter settings | Defines use of the pulse counter inputs. Use requires related SW option in unit. |

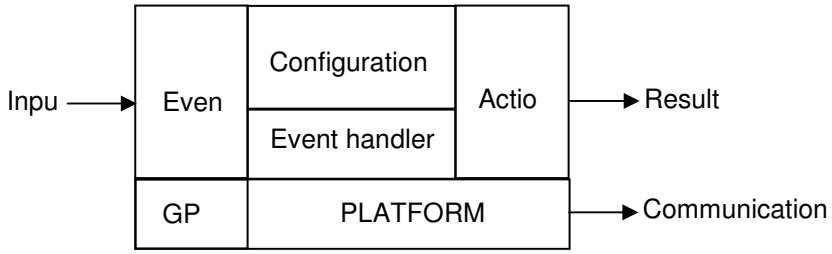
## 3.4 Events and Actions

The heart and soul of the A9 software is it's fully configurable, event-based action execution engine. This engine enables users of A9 to create new ways of working simply by configuring the unit's event action rules. The configuration is stored to A9 file system as an xml file. This file can be created and downloaded with the configurator tool. It is also possible to edit and upload this xml file to the unit manually.

A9 software includes optional state flags that offer state machine type approach (AND/OR/IF) making it possible to implement complex functionality where needed events and related actions are performed only if defined conditions are met. Available are 48 user definable flags and additionally two flags for IO use (IO1 and IO2).

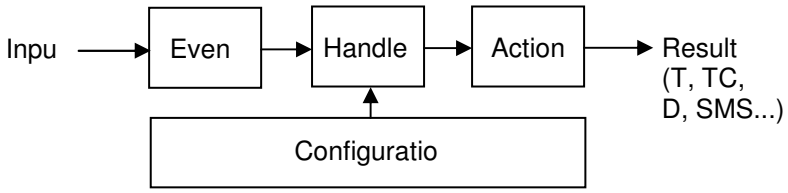
The engine configuration consists of two components: eventHandlers and actions:

- An **eventHandler** receives an event from the system, checks the event's type and associated parameters and tells the engine if it accepts the event for processing.
- An **action** does something, for example, activates an output or sends a message to the server.




The basic operating principle of the engine together with the configuration file is very simple:

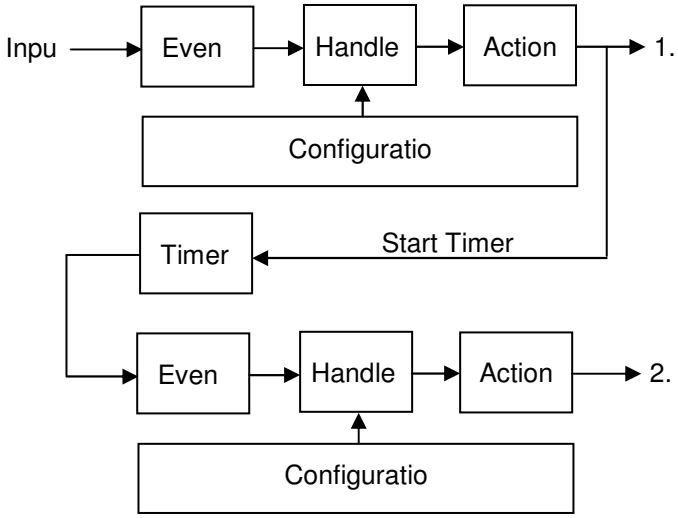
1. Whenever the engine receives an event from the system, *it will...*
2. check if an eventHandler has been configured for that event.
3. If yes, the engine will then check what actions have been defined for that eventHandler, *and...*
4. executes the actions.




Each eventHandler may have one or more actions associated with it. There may also be multiple instances of each eventHandler and action. This enables unlimited combinations and is limited only by total memory and performance limits.

Following block diagram describes one example of a bit more complicated process including also timer:

1. Whenever the engine receives an event from the system, *it will...*
2. check if an eventHandler has been configured for that event.
3. If yes, the engine will then check what actions have been defined for that eventHandler, *and...*
4. executes the actions (as a 1. Result).
5. Same time it starts the timer, which executes another input for the event after configured time
6. Whenever the engine receives an event from the system, *it will...*
7. check if an eventHandler has been configured for that event.
8. If yes, the engine will then check what actions have been defined for that eventHandler, *and...*
9. executes the actions (as a 2. Result).



### 3.4.1 Events

Available events are listed in the table below.

| EVENT | FIRED WHEN |
|---|---|
| AD_TRESHOLD | AD input threshold value crossed ↑ ↓. |
| ALARM_ACTIVE | Periodically when an alarm is active. |
| BATTERY_LOW | Voltage of internal battery is near the critical limit. |
| COMM_FAIL | Device communication failure is detected. |
| COMM_SESSION_CLOSED | Any communication channel is closed due to timeout, transport disabling, etc. |
| DATA_EVENT | Data from defined source is received. |
| DIRECTION_CHANGED | A change in GPS direction detected. |
| DISTANCE_TRAVELED | A defined distance travelled since previous event_distance_travelled. |
| DLKP_STATE_CHANGED | DLKP selected state changes. |
| DLKP_EMERGENCY_PRESS | Any DLKP button has been pressed continuously for a configurable time. |
| FLAG_CHANGED | One or more flags have changed with CHANGE_FLAGS action. |
| GEOFENCE | A geofence is entered or left. |
| GPS_HARSH_BRAKING | GPS data indicates speed change exceeding the configurable limit value. |
| GPS_RAPID_ACCELERATION | GPS data indicates speed change exceeding the configurable limit value. |
| GPS_STATUS_CHANGED | When GPS fix is lost or found. |
| IBUTTON | iButton status has changed. |
| IGN_OFF | Ignition line is deactivated. |
| IGN_ON | Ignition line is activated. |
| INPUT_CHANGED | State of a digital input is changed. |
| NET_CHANGED | GSM network status changes. |
| OUTPUT_CHANGED | State of an output is changed. |
| POWER_SUPPLY_CHANGED | Main power supply status changes |
| SCHEDULED_EVENT | RTC clock reaches the time defined by a scheduled event. |
| SOFTWARE_START | Software application is started. |
| SPEED_LIMIT | GPS velocity rises above or falls below defined speed limit . |
| START_MOVING | Device has started moving. |
| STOP_MOVING | Device has stopped and stands still. |
| TEMP_HIGH | Temperature of the device or internal battery rises above high limit. |
| TEMP_LOW | Temperature of the device or internal battery falls below low limit. |
| TEMP_OK | Temperature of the device or internal battery returns to normal range. |
| PULSE_COUNTER_DATA* | Pulse counter data. |
| PULSE_COUNTER_RATE_LIMIT_CROSSED* | Pulse counter rate has reached set limit. |
| PULSE_COUNTER_STATE_CHANGED* | Pulse counter has started or stopped receiving pulses (activity, no activity). |
| FMS_CRUISE_CONTROL* | Cruise control status changes (driving economy) |
| FMS_OVERTEMP* | Engine temperature rises above or falls below threshold value |
| FMS_OVERREVOLUTIONS* | Engine rpm rises above or falls below threshold value |
| FMS_OVERSPEED* | Over speeding status has changed |
| FMS_HARSH_BRAKING* | Vehicle de-acceleration higher than user configured limit value/second |

Note *: Requires SW option

#### 3.4.1.1 AD threshold

Tracking software can monitor AD input values of A9 and also the voltage of main power and generate AD_THRESHOLD event once when threshold limit is crossed. Each AD channel can have up to four configurable threshold values.

#### 3.4.1.2 Alarm

ALARM can be activated/deactivated as a response to any event. When fired it normally creates first event immediately and after that it repeats event at defined time interval. First alarm event can be delayed and also deactivated before its launch.

#### 3.4.1.3 Battery LOW

This event is available only if optional internal battery is installed.

BATTERY_LOW event is created, when the voltage of the internal battery is close to critical limit.

#### 3.4.1.4 Comm fail

COMM_FAIL event is created when device communication failure is detected. With this it is possible to act in situations where for example all servers are down or roaming is prevented. It is sent after automatic GPRS reattach attempt fails.

#### 3.4.1.5 Comm session closed

COMM_SESSION_CLOSED is generated when any communication channel closes due to for example timeout or transport disabling. It enables communication-based actions when physical connection is closed (for example concatenating messages resulting reduced message overhead).

#### 3.4.1.6 Data event

DATA_EVENT is generated when data from SMS, TCP or COM1 is received. Received data can be used as a parameter for SEND_DATA action enabling for example sending text message to another receiver as a SMS.
With this function it`s possible to control many different kind of peripheral devices that are connected to A9 COM1 port. It makes transparent communication between server and device when persistent TCP connection is kept on. For example reading RFID tag data is possible to collect to the server with this method. A9 can be configured to send local commands to external device and the command results can be sent to server transparently or as part of the D-protocol data snapshot. Also message based communication protocol for external device like PDA is easy to arrange with data events.

#### 3.4.1.7 Direction change

DIRECTION_CHANGED detection is based on the heading parameter of GPS position information. An event is generated every time heading is changed more than defined with parameters DirectionChangeAngle_deg and DirectionChangeTimeWindow_s. The algorithm compares the current position against the previous positions and rejects any positions older than defined in DirectionChangeTimeWindow_s.

#### 3.4.1.8 Distance traveled

DISTANCE_TRAVELED algorithm uses built-in trip meter of A9 device. It creates an event every time, when predefined distance (DistanceBetweenEvents_m) has been achieved. Because of the flutter in GPS signalling, trip meter distance is not added if increment is less than 15 meters and the velocity of the vehicle is less than 5km/h.

#### 3.4.1.9 DLKP state changed

By pressing one of the buttons of Aplicom DLKP generates a DLKP_STATE_CHANGED event to the application. The ID of pressed button is attached to the event snapshot information.

#### 3.4.1.10 DLKP emergency press

DLKP_EMERGENCY_PRESS event is generated when any DLKP button is pressed continuously for a certain, configurable time. It does not cause any additional actions or any on/off information by itself. User must configure required functionality in configuration. The ID of pressed button is attached to the event snapshot information.

#### 3.4.1.11 Flag changed

It is possible to set, clear and monitor user defined flags. Purpose of flags is to enable state machine like behaviour.
FLAG_CHANGED is created, when one or more flags monitored by this event type has been changed with change_flags action. This makes it possible to define several states that can have different functionality.

#### 3.4.1.12 Geofence

GEOFENCE monitoring is based on GPS coordinates and circular geofences. Multiple geofence areas can be defined by selecting suitable center point and defining needed radius for it. An event is generated when entering the geofence and other event is created when leaving it. All geofences are handled separately, so multiple geofences can be entered and exited at the same time. Events are created separately for all geofences. Due to GPS positioning inaccuracy and preventing jitter ±5% hysteresis has been set to the radius of geofences.

#### 3.4.1.13 GPS harsh braking

GPS_HARSH_BRAKING is generated, when GPS data indicates speed change exceeding the configurable limit.

#### 3.4.1.14 GPS rapid acceleration

GPS_RAPID_ACCELERATION is created, when GPS data indicates speed change exceeding the configurable limit.

#### 3.4.1.15 GPS status changed

GPS_STATUS_CHANGED is generated when a GPS fix is lost or found.

#### 3.4.1.16 IButton

IBUTTON event is created when iButton status used for driver identification is changed. Tracking software keeps track of iButton login state automatically. By default iButton logout is done at poweroff, but no event is created. Therefore each software start event corresponds to iButton logout if login has occurred.

#### 3.4.1.17 IGN OFF/ON

IGN_OFF event is generated, when the ignition line has been deactivated. IGN ON event is created, when the ignition line has been activated.

#### 3.4.1.18 Input changed

INPUT_CHANGED event is generated, when the state of a digital input pin has changed. There are two digital inputs available.

#### 3.4.1.19 Net changed

NET_CHANGED event is generated whenever used GSM network status is changed. This event can be used to control possible roaming functionality when there's risk of getting for example additional costs of roaming when travelling near nation borders or abroad.

#### 3.4.1.20 Output changed

OUTPUT_CHANGED event is generated, when the state of an output has changed. There is one output available.

#### 3.4.1.21 Power supply changed

POWER_SUPPLY_CHANGED event is created whenever the main power supply status is changed from main power supply to internal battery and vice versa.

#### 3.4.1.22 Scheduled event

SCHEDULED_EVENT is generated, when the RTC clock reaches the time defined by scheduled event parameter. These events are either one-time or repeating events that occur in defined time.

#### 3.4.1.23 Software start

SOFTWARE_START event is generated, when application of A9 has been started successfully. Before this event is launched, application has been configured and its all services are running, also including communication.

#### 3.4.1.24 Speed limit

SPEED_LIMIT monitoring is based on the velocity parameter of GPS position information. It compares the velocity in the current GPS position information to value set in SpeedLimit_kmh parameter. An event is created once, when set limit value is exceeded and once when it is again fallen below the limit. Speed limit monitoring has ±5% hysteresis due to GPS positioning inaccuracy and preventing jitter.

#### 3.4.1.25 Movement detection (Start_moving and Stop_moving)

Movement detection is based on built-in trip meter of A9 device. It creates an event every time vehicle starts moving or stops moving according to predefined parameters MovingCheckDistance_m and MovingCheckTimeWindow_s. Because of the flutter in GPS signalling, trip meter distance is not added if increment is less than 15 meters and the velocity of the vehicle is less than 5km/h.

#### 3.4.1.26 TEMP LOW/TEMP OK/TEMP HIGH

TEMP_LOW event is generated, when temperature of the A9 device or the internal battery falls below the low temperature alert limit.

TEMP_OK event is generated, when temperature of the A9 device or the internal battery returns to normal range.

TEMP_HIGH event is generated, when temperature of the A9 device or the internal battery rises above the high temperature alert limit.

#### 3.4.1.27 Pulse counter data

Defined pulse counter data available. A1 SW can store samples of average pulse rate over set time interval. A9 SW uses separate sample buffers for each pulse counter. A sample buffer can contain defined number of samples. Pulse counter data event containing the sample buffer data is generated when the sample buffer is full. The sample buffer can be transferred to server as raw data or in a D protocol snapshot. To use this feature Pulse counter SW option needs to be used.

#### 3.4.1.28 Pulse counter rate limit crossed

Pulse counter has reached set rate limit, pulses per set time interval. To use this feature Pulse counter SW option needs to be used.

#### 3.4.1.29 Pulse counter state changed

Event is generated when pulse counter has started or stopped receiving pulses in set time interval (activity, no activity). To use this feature Pulse counter SW option needs to be used.

#### 3.4.1.30 FMS over speed

FMS OVERSPEED is generated when FMS overspeeding status has changed. It is read from FMS-CAN tachograph data.

#### 3.4.1.31 FMS over temp

FMS OVERTEMP is generated when FMS-CAN engine temperature rises above or falls below threshold value.

#### 3.4.1.32 FMS over revolutions

FMS OVERREVOLUTIONS is generated when FMS-CAN engine speed rises above or falls below threshold value.
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#### 3.4.1.33 FMS cruise control

FMS CRUISE CONTROL is generated when FMS-CAN cruise control status changes.

#### 3.4.1.34 FMS harsh braking

FMS HARSH BRAKING is generated when FMS-CAN harsh braking status changes

### 3.4.2 Actions

Available actions are listed in the table below.

| ACTION | ACTIONS |
|---|---|
| ACTIVATE_ALARM | Activates an alarm. |
| DEACTIVATE_ALARM | Deactivates an alarm. |
| CHANGE_PARAM_SET | Changes active parameter set. |
| CHANGE_COMM_LEVEL | Changes communication priority. |
| INVERT_OUTPUT | Inverts the state of an output. |
| SET_OUTPUT_ACTIVE | Activates an output. |
| SET_OUTPUT_INACTIVE | Deactivates an output. |
| LOG_MESSAGE | Writes a message to application debug log. |
| SEND_SNAPSHOT | Records a status snapshot and queues it for sending. |
| SET_LED | Changes LED state. |
| SHUTDOWN | Shuts the device down. |
| UPDATE_QUERY | Sends an update query to remote update server. |
| SEND_DATA | Sends a message to defined destination. |
| CHANGE_FLAGS | Changes one or more flag bits from the device. |
| IBUTTON_LOGOFF | Performs iButton logoff function. |
| RESET_TRIP_VALUE | Clears Trip2 meter value. |
| RESET_PULSE_COUNTER* | Resets pulse counter. |
| SET_DLKP_STATE | Sets selected DLKP state. |
| CHANGE_TO_ANOTHER_APPLICATION | Unit reboots to other defined application. |
| SEND_CAN_SNAPSHOT. | Records a status snapshot of FMS CAN data and queue it for sending |
| | |
| | |

Note *: Requires SW option

#### 3.4.2.1 Activate Alarm

ACTIVATE_ALARM activates valid alarm defined in the alarms section of the configuration. When set to active, alarm works like scheduled event: it is repeated at intervals defined in the configuration until the DEACTIVATE_ALARM is received or unit powers off.

#### 3.4.2.2 Deactivate Alarm

DEACTIVATE_ALARM deactivates valid alarm defined in the alarms section of the configuration.

#### 3.4.2.3 Change Parameter set

CHANGE_PARAM_SET changes the current active parameter set to defined new one.

#### 3.4.2.4 Change Comm Level

CHANGE_COMM_LEVEL changes communication priority overriding any earlier settings.

#### 3.4.2.5 Invert Output

A9 has two programmable digital outputs with IDs 1 and 2. INVERT_OUTPUT inverts the state of an output pin.

#### 3.4.2.6 Set Output Active

A9 has two programmable digital outputs with IDs 1 and 2. SET_OUTPUT_ACTIVE activates an output pin.

#### 3.4.2.7 Set Output Inactive

A9 has two programmable digital outputs with IDs 1 and 2. SET_OUTPUT_INACTIVE deactivates an output pin.

#### 3.4.2.8 Log Message

LOG_MESSAGE writes a message to application debug log at INFO level. Debug log is printed to serial port COM2 of the A9. Debug log can be read by using A9 Data cable, D9 female (D337005).

#### 3.4.2.9 Send Snapshot

SEND_SNAPSHOT records the device status snapshot and queues it for sending according to defined priorities and selected transport.

#### 3.4.2.10 Set Led

A9 has one application controlled LED, which supports four states: off, green, red and orange. SET_LED changes led state.

#### 3.4.2.11 Shutdown

SHUTDOWN powers down A9 in a controlled way.

#### 3.4.2.12 Update Query

UPDATE_QUERY sends a configuration update query to remote update server. If a new configuration or SW is available, it will be installed in a non-volatile memory of the EGS5 GSM module and device reboots automatically after successful update. Old configuration is automatically saved as a backup and if updated configuration is not successful, old configuration is taken into use in the reboot.

This mechanism is very flexible and reduces maintenance work because it can be fully automated process working background and there is no need for separate manual OTA actions or use of SMS OTAP.

#### 3.4.2.13 Send data

SEND_DATA sends a message to server using any defined transport or to serial port COM1.This action takes data from data event as a parameter and sends it to the destination in textual or in hexadecimal format.

#### 3.4.2.14 Change flags

With CHANGE_FLAGS action it is possible to determine flags to be set and flags to be cleared when executing this action.

#### 3.4.2.15 IButton logoff

IBUTTON_LOGOFF logs out iButton key if one is logged in.

#### 3.4.2.16 Reset trip value

RESET_TRIP clears the value of the TRIP2 meter. TRIP1 value is not reset as it is used for total distance calculations.

#### 3.4.2.17 Reset pulse counter

Resets pulse counter to 0. This requires Pulse counter SW option.

#### 3.4.2.18 Set DLKP state

Sets selected DLKP state. DLKP device is replaced with 3PAD key pad.

#### 3.4.2.19 Change to another application

Unit reboots to other defined application. TBD, reserved for future use.

#### 3.4.2.20 Send CAN Snapshot

Records a status snapshot of FMS CAN data and queue it for sending according to defined priorities and selected transport.

### 3.4.3 Communications settings

Communication is handled in three parts: connection, transport and formatters.

#### 3.4.3.1 Connection

Connection defines what GSM bearer and transport layer protocol (connection type) should be used to send a message. Connection can be configured as persistent trying to keep GPRS and TCP connection always open for efficient data transfer when frequent sending is needed or two way TCP/IP communications is needed to be possible to use from server. If connection is lost, next sending attempt will open the connection again or a separate alive message can be used to reopen the connection after configured time interval. Configurable timeout functionality for persistent TCP/IP connection is also available to close it after two way communication is completed. In non persistent use, the unit opens new connection for each sending of data snapshot and closes the connection after that.

#### 3.4.3.2 Transport

Transport binds together connection, formatter and a **destination** of the sent message.

**Destination** is the IP address and socket where snapshots are to be sent. There can be individual settings for different transports thus making it possible to serve several servers at the same time.

#### 3.4.3.3 Formatter

Formatter defines how the message should be formatted before sending.

Different protocols are supported:

- D : (Data) for sending snapshot data in binary data format.
- TC : (Text Compact) for sending snapshot data in a compact CSV compatible format.
- TV : (Text Verbose) for sending snapshot data in human-readable, plain text format.

# 4 A9 OPTIONS

This section provides information of A9 SW and feature option upgrade mechanism and descriptions of currently available A9 SW options for the A9 product.

## 4.1 Option upgrade mechanism and process

A9 product options are normally ordered and delivered so that unit has all needed options included. When units need to be upgraded with new features at field Aplicom has defined procedures to do so, in limits of A9 capabilities and available SW options. The SW options may include also some HW options activation if the resource is needed for the SW option to run.

Before getting the upgrade the wanted options need to be ordered from Aplicom and following steps need to be taken to complete the upgrade of units. The units that will be upgraded are identified by IMEI and serial numbers of the units.

Based on given information Aplicom delivers an updater software (updater .jar and .jad files) that customer downloads to each unit to be upgraded and when this software is run once the unit is ready for running the ordered SW option. The download to A9 units can be done locally with A1 SW configurator or by over the air (OTA) method.

After this the upgraded unit is able to run the A9 software with selected activated SW options. Process may also require downloading the new version of A9 SW to have the latest release in use.

Aplicom stores the updater software packages with unique product code and registers the upgraded units to product information database.

A separate Application note *K505029 A9 Option Upgrade Process* is available on Aplicom Partner Extranet.

## 4.2 A9 Options

(at the time of writing)

### 4.2.1 Pulse counter for A9

With this SW option A9 inputs can be used to measure pulses in several different configurable ways. The results can be sent to backend system in Aplicom standard D protocol.

Pulse rate can be configured to have limits creating events when they are crossed to trigger actions or snapshot sending etc.

Total pulse count and average pulse rate over configured period of time and monitoring pulse counter state (receiving/not receiving pulses) can be used for example for activity monitoring.

A9 pulse counter interface can be used in Input 1 and Input 2 interface.

The functionality is described in detail in *K520050 A9 SW User Manual*, available in Aplicom Partner Extranet.

### 4.2.2 A9 CAN ID forwarder SW for A9

The CAN ID forwarder SW for A9 is software option that makes possible of reading a set of selected CAN messages from vehicle CAN bus. The option can be used safely with Aplicom contactless CAN reader to monitor vehicle CAN bus messages. Due to high data rate at vehicle CAN bus, only selected set of maximum 64 different CAN IDs can be monitored. Also other types of CAN bus traffic e.g. in working machines and special vehicles can be monitored with this SW option.

The monitored CAN IDs are configured in A9 configuration. In configuration it is also possible to set the read interval and events that activate the read and send the current values of latest stored CAN message data. The data is then sent to backend system in Aplicom D protocol data snapshot as data event data. Backend system then needs to convert the data to format that is suitable for further use of the received CAN data.

The functionality is described in detail in *K520050 A9 SW User Manual*, available in Aplicom Partner Extranet.

When ordering A9 units with this option, A9 units will be delivered with CAN use enabled.

### 4.2.3 Garmin SW IF for A9

This software option for Aplicom A9 and A9 GLONASS enables combining of messaging and navigation with tracking and fleet management systems using standard Garmin navigators, which support Garmin Fleet Management Interface™.

**Note:** When this option is ordered, Garmin SW Interface and standard Aplicom A9 software are pre-installed in the A9 device. They can also be upgraded later with the Aplicom A9 Option Update service (order code: D234000).

### 4.2.4 FMS CAN SW option for A9

This SW option enables A9 to be used with vehicle FMS interface. The A9 FMS interface supports FMS 2.0 standard dataset. The A9 FMS uses Aplicom A1 F Protocol (S100302), version 4.0 to communicate with the back-end system.

### 4.2.5 A9 CAN update for SDK users

With this SW option A9 CAN interface is updated to be available for SDK users.

It opens CAN receive functions for FMS use and use for Aplicom Contactless CAN reader use. Also CAN send possibility is open for two way CAN communications.

### 4.2.6 A9 COM update

With this SW option A9 COM port is available for application use. This option is needed for A9 SW and SDK users to be able to use COM1 port of the A9 to application use. In basic use the port is available only for configuration and SW management use with A1 SW configurator.

In A9 SW the serial port data events can use the COM port for two way communications. In SDK use Java application can freely use the port for application needs.

### 4.2.7 FMS CAN update for A9 SDK users

With this SW option the A9 FMS interface is updated to be available for SDK users to support FMS 2.0 implementations.

### 4.2.8 ACC activation for A9 SDK users

This SW option allows Java application developers to use 3D acceleration information that is available from A9 unit's internal acceleration sensor. The acceleration sensor is able to automatically calibrate itself to installed position with included system SW functions in the Java SDK. Java application gets 3D acceleration information per reading interval. The data includes x, y and z axis actual acceleration and mean acceleration during the read interval.

# 5 A9 SDK USE

This section provides information of A9 use with custom applications developed with SDK.

## 5.1 A9 SDK support

The SDK for A9 will be available for registered Aplicom partners on Aplicom Partner Extranet on Q4/2012.

The SDK is largely based on A1 SDK, but will have separate API documentation which shows the set of the features that A9 supports. New release of Cinterion EGS5 Java engine (equals TC65i in features) requires library references to be converted to Cinterion naming. This is done in released A9 SDK.

Porting A1 applications to A9 should be straight forward process. It is necessary to take care of the differences of interfaces of the product. Also part of the A9 HW resources will need activation with ordered SW options upgrades before they can be used.

# 6 A9 TECHNICAL DETAILS AND INTERFACES

This section provides information of technical details and gives also a detailed description of the interfaces of A9 unit.

## 6.1 Some more technical details of A9

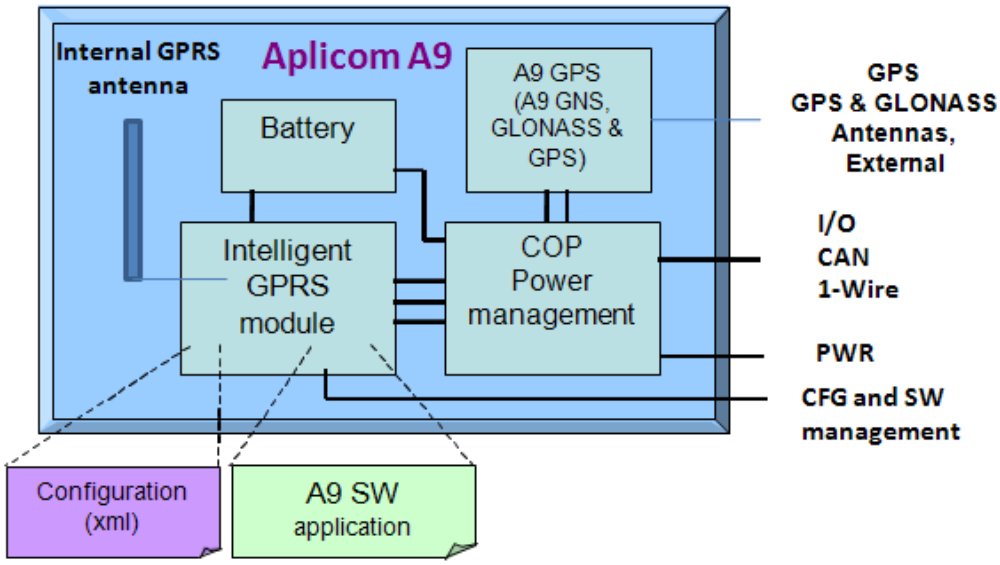



Figure 3 General Diagram of A9

Used GPRS platform is Java IMP 2.0 programmable Quad-Band GPRS multislot Class 12 module. A9 also includes ARM7 co-processor (COP), which handles realtime processing and watchdog functionality. The unit has a wide input voltage range (6,8…32Vdc) with typical current consumption of less than 100mA.

A9 GPS receiver is a 50-channel supersense module, which is under co-processor control. A9 GLONASS GPS&GLONASS receiver is capable of receiving both GPS and GLONASS signals and therefore has better accuracy in positioning than GPS only solution.

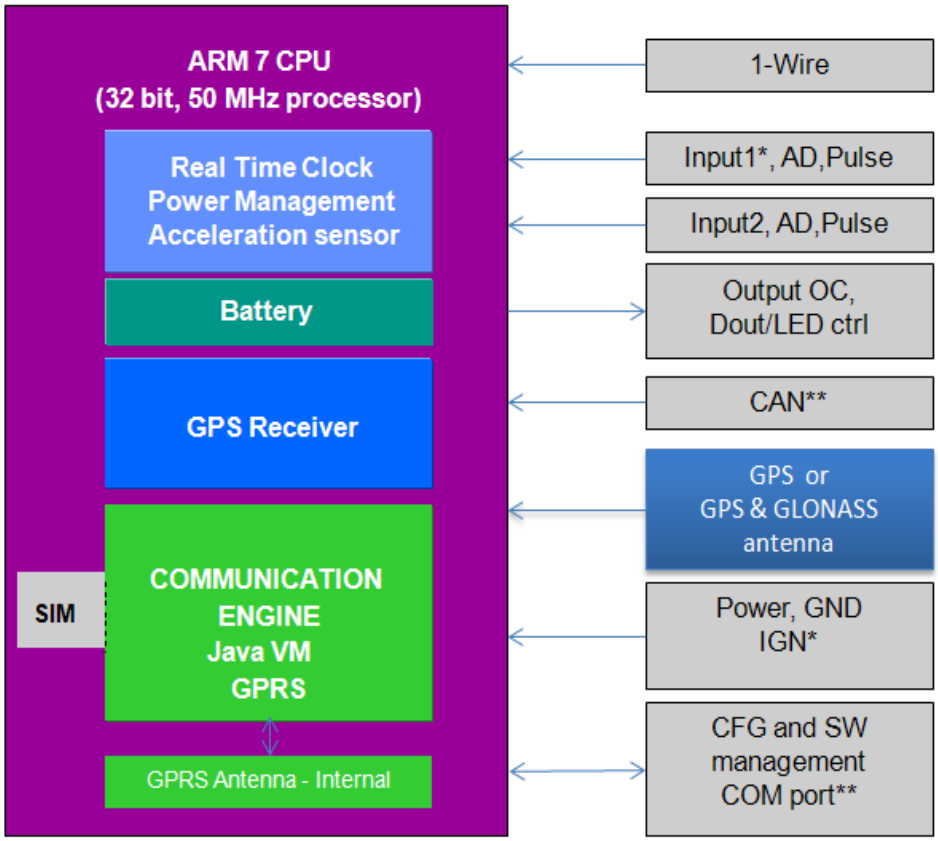
User interface for A9 includes one LED which is under SW control. Unit SIM is under top cover and it can be inserted without needing any tools. A9 uses normal size SIM cards or micro SIMs with suitable adapter.

A9 has a Real Time Clock (RTC) for maintaining the current time and date. RTC is synchronized when the GPS fix is available. Additionally A9 has an RTC- based wakeup functions.

Internal Li-Ion backup battery for full operation backup.

A9 power control is done with IGN input (input > 6.8Vdc, IGN active) and software controlled switch off. Also movement detection can wake up the unit if configured in use.

Please refer to *A9 datasheet M100800* for more detailed information.




Note *: IGN and Input1 use the same physical input. They are used alternatively. Selection is made in A9 configuration.
Note **: Use requires suitable SW options

Figure 4 A9 Interfaces

## 6.2 Common interfaces

### 6.2.1 CFG and SW management interface

The port is used to connect the A1 SW configurator for configuring the unit and also downloading SW locally.

The interface is serial port connection which is physically available in micro USB connector.

It can be used to connect to external device with data events and other uses with separately ordered SW options. The options will be introduced later.

## 6.3 Power supply

Power input voltage is 6,8 to 32 VDC. The power is connected to system cable. Supplied IGN input function can be used for controlling the ON/OFF state of A9 unit. Its status and also change information are monitored by the application, thus waking up the unit can be made by activating IGN -line. Shutting down the unit is done either by non activating the IGN -line or it is controlled by configurable PowerOffDelay.

The IGN line is physically same input for the A9 unit. The selection how this information is handled in A9 is done in A9 SW configuration. If the input is used not as IGN information, other wake-up conditions for the unit must be used. They are defined in configuration as wake up conditions. Typically it can be the wake up for movement detected by internal acceleration sensor.

Power and IGN lines must be fuse protected in installation. The fuse must be selected to be able to protect the wiring of the unit. Unit uses maximum power spike of 1A at start up and the selected fuse must be capable of

handling that. If laboratory power supply is used to supply the unit while configuring or other use, the current limitation must be set to 2A or higher to guarantee stable supply for the unit.

GND shall be connected to vehicle chassis with a short wire.

Internal Li-Ion battery works as a backup for the unit power supply. It offers full power operation according to programmed functionality. The user application can detect primary power disconnection, and perform predefined operations. The capacity of the internal battery is selected so that its main function is to stabilize external power supply interruptions to keep the unit operation stable. Also sending of pending messages or alarm generated from cutting the power supply wires can be sent. Since the backup battery is capable of supplying the unit for full operation, it can be used to power the unit for longer time as well by using the intelligent power management of the unit. By configuring the unit to use power down sequences, for example wakeup and positioning, the unit can be made during longer period of time.

### 6.3.1 IO's

There are two multifunctional inputs available in A9 unit. The way the inputs are used can be selected in unit configuration. Physically they are in A9 nine pin connector based on Molex Microfit series.

#### 6.3.1.1 Digital inputs

Digital inputs (2 pcs) are used for monitoring digital input state. They can be directly fitted to all vehicle voltage levels from 0 to 32 Vdc. The input range is in range 0…5Vdc.

#### 6.3.1.2 Analogue inputs

Analogue inputs (2 pcs), which are parallel with digital inputs above, are used for voltage level measurements. Their voltage range is from 0 to 5 Vdc as above.

#### 6.3.1.3 Pulse counter inputs

Pulse counter inputs (2 pcs), which are parallel with digital inputs above, are used for pulse counting of the digital input. Their voltage range is from 0 to 5 Vdc as above. The use of this function requires equalling SW option for the unit.

#### 6.3.1.4 Open collector output

Open collector output is e.g. for controlling external relay or other device. It can drive (pull down) max. 150 mA switching current. It can be used alternatively as digital output for example for directly driving a LED. It has an internal series resistor to limit the LED current.

#### 6.3.1.5 1-wire

1-wire (iButton) interface is used for connecting iButton with pre-programmed unique identification code for driver identification purposes. LED indicator shows status indication (successful/failed registration). It has a 3 pin Molex Microfit series connector (1-Wire).

Aplicom 3PAD keypad can be connected to 1-wire bus. 3PAD can be used for electronic driver logbook functions or monitoring driver and vehicle working status. It suits also for safety and security, as well as service applications. DLKP status is stored into nonvolatile memory, so unit will remember the status also over the normal power down cycle. Power cut cycle that resets the Co-processor also zeroes the state.

#### 6.3.1.6 CAN interface

Aplicom A9 has one CAN interface available when required SW options are installed in the unit. It can be used with FMS data reading with FMS interface for A9 SW option and with CAN ID forwarder SW option to read alternative CAN data. The FMS CAN interface is a SAE J1939 compatible CAN interface. It can be set to normal CAN speed

values and it supports the required addressing modes. The data comes in twisted pair cable with symmetrical CAN signal. The can information is only read in and no data is sent to the CAN bus.

## 6.4 Antennas

A9 has internal antenna for GPRS use. Installation place must be selected so that the antenna has good reception and sending conditions, and also so, that don`t cause disturbance to neither vehicle electronics nor car radio equipment. A9 uses external GPS active antenna with MCX connector. The antenna gets 3Vdc power supply from A9.

A9 GLONASS uses external combined GPS and GLONASS capable active antenna. The antenna gets 3Vdc power supply from A9.

# 7 CONFIGURING THE A9 UNIT

The A9 SW configuration file is a human readable, plain text file, and can be edited using any text editor. The configuration itself is described in the file using well-formed *eXtensible Markup Language* (XML). The configuration file is essential when defining the overall performance and needed features of the A9 unit.

Some of the configurable parameters need to get values from GSM/GPRS operator in use. These include for example APN, username and password for network.

A new configuration is downloaded to the A9 unit wirelessly with the OTAP controller or locally through the configuration and SW management interface, with A1 SW configurator. Please refer to chapter 9 for further information of OTA.

Configuration file includes following elements:

| Section | Description |
|---|---|
| XML Headers | File starts with a header. |
| Parameter sets | Parameters affect the behavior of A9 Track SW services.<br>They are defined in this section. |
| I/O configuration | A/D monitoring feature configuration.<br>Threshold levels and reading interval of A/D is defined here. |
| Communication | Connections, Formatters and Transports are configured here. |
| Alarms | Configuration of alarms. |
| Geofences | Centerpoint and radius of geofences are defined in this section. |
| Scheduled events | Events occurring at defined time once or repeatedly. |
| Actions and eventHandlers | The Actions and Events are configured and linked together here. |
| Communication interface settings | COM1 settings. |
| Flags | Statemachine flags. |
| Configuration footer | A configuration is ended with closing tag. |

Please refer to *K520050 A9 SW User Manual* for further information on configuration of the device.

## 7.1 Making A9 Configuration settings with deployment option

A9 SW configuration can be partly changed with inbuilt deployment functions. This means that some parameters, like GPRS APN, username, password and server address can be changed simply by sending a text SMS message to the unit. This text message is formatted in specified way to make the setting and to be stored into A9 memory as non volatile variable. This means that the setting is valid after that and is not changed until new setting is made or A9 configuration is changed.

The same mechanism can also be used to select unit configuration if several configurations are stored into unit.

See *K520050 A9 SW User Manual* for details of using this mechanism.

## 7.2 A1 SW Configurator (Used also for A9 configuration and SW management)

Aplicom A1 SW Configurator is the PC application software for creating configurations for Aplicom A9 Track SW and updating these configurations to A9 devices. The Configurator offers three different ways of creating and editing the configurations, a configuration wizard, advanced configuration editor and a text editor for editing the XML configuration files.

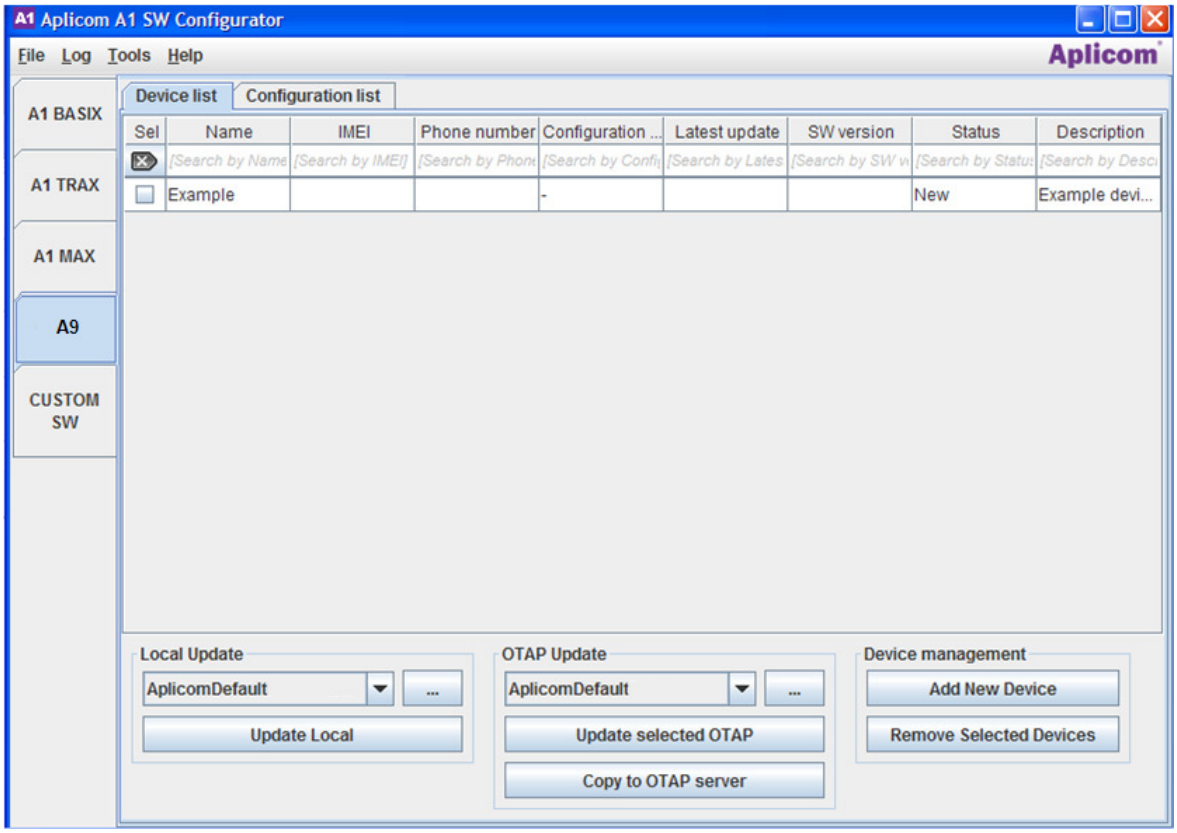



Figure 5 General view of the configurator

The Configurator can update A9 devices locally using serial cable or remotely using Over-The-Air-Provisioning (OTAP).

Please refer to *K503021 Aplicom A1 SW Configurator User Manual* for further information of the Configurator.

# 8 SOFTWARE CONFIGURATION UPDATE

## 8.1 OTA update

A9 supports Over-The-Air update of the Track SW XML configuration. A9 sends a request to server about possible new updated configuration and if it`s available, it`s downloaded to A9.

The downloaded configuration is stored in the Flash memory of EGS5 GPRS module. Once the download is finished the A9 device reboots up and the new configuration is activated next time the application is started. Old configuration file is left as a backup to the unit, and if rebooting is not successful with the updated configuration, the old configuration is set active again.

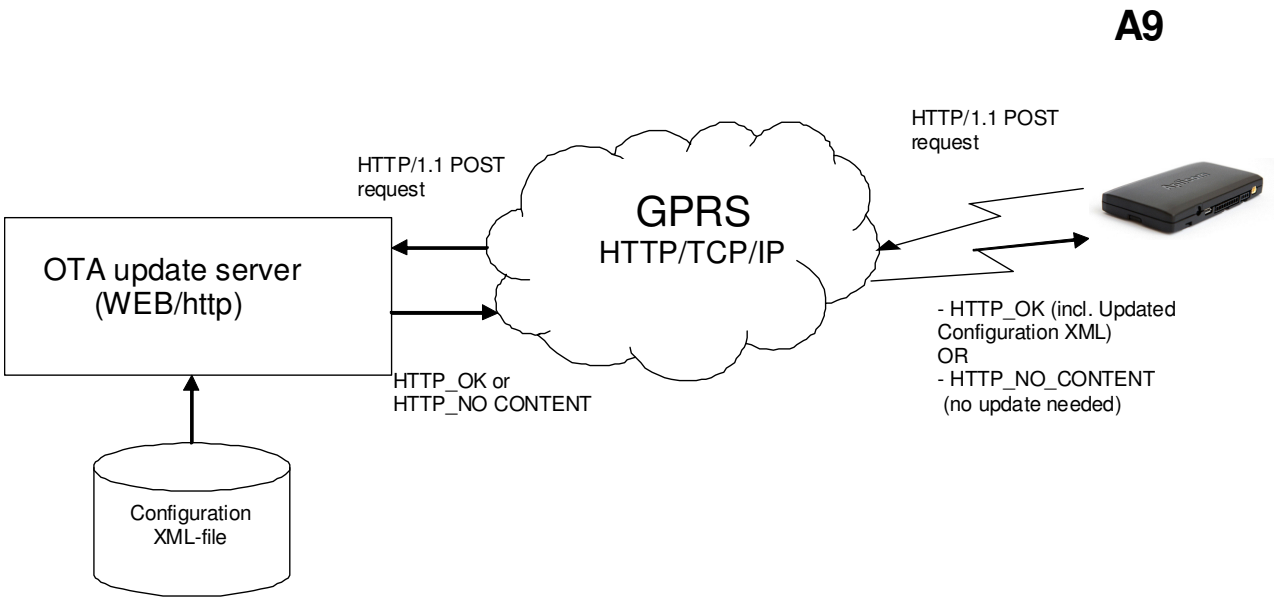



Figure 6 OTA configuration update mechanism

## 8.2 Manual update

A9 Track SW expects the XML configuration file to be found in the location:

A:/config/

New XML configuration file can be copied to this location using a A9 Data cable D9 female, code: D337005 connected to CFG and SW management port of A9 device and Module Exchange Suite (MES) tools.

Please see *K503051 A1 Track SW and Telematics SW Configuration Update Manual* for further information about updates.

# 9 OTA SOFTWARE UPDATE MECHANISM

The principle of OTA software update mechanism is as follows:

Over The Air Provisioning (OTAP) Controller sends an SMS message to A9 informing about available software update on WEB server. Aplicom A1 Configurator PC software can be used to make this. Because of standard procedures the same mechanism can be also built to customers own server environment. A9 sends an OTA request over GPRS to WEB server informing to be ready for OTA software update. WEB Server then updates .jar- and .jad-files i.e. the application through GPRS into the A9. After the update the A9 unit boots up to the new application.

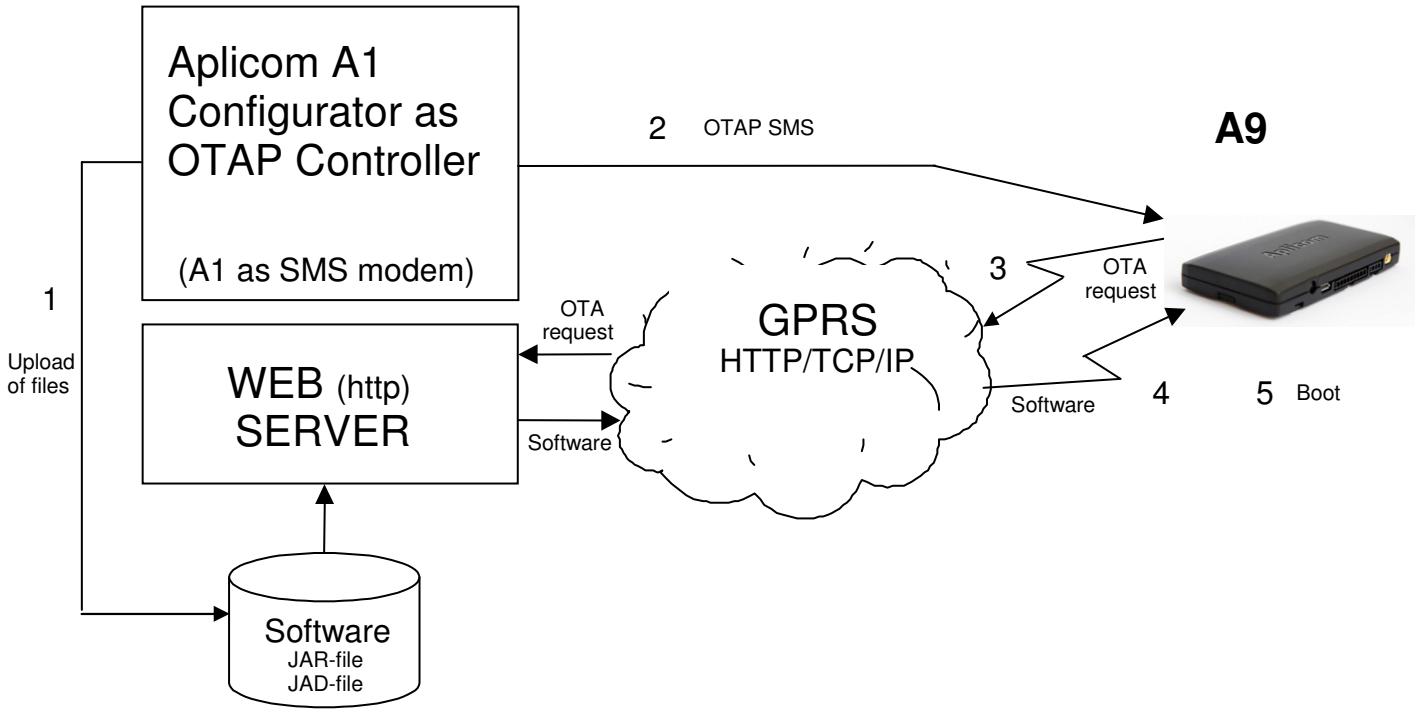



Figure 7 OTA software update mechanism