Nomadic Device Integration
in AIDE

Mike Gardner - Motorola
The nomadic device gateway developed by Motorola within the AIDE project is functioning and integrated into the AIDE demonstrator vehicles.

The gateway developed covers the three main communication classes of integration with nomadic devices.
- Device to vehicle
- Vehicle to device
- Device and vehicle cooperation

The underlying communication technology is scalable, platform independent, transport protocol neutral and very lightweight.

Tools to assist with bench development (Phone simulator, Vehicle sensor simulator) have been developed to allow fast integration into real vehicles.
Nomadic Device Gateway Philosophy

The Vehicle NDG is always looking to discover nomadic devices as they are carried into the vehicle.

As devices are discovered they exchange messages to automatically configure themselves to each others corresponding capabilities and continually exchange context and external events.

The vehicle ICA is used to control and pace the method and modality of all user interactions between the user and the device/vehicle.

Any nomadic device’s content can be displayed and/or selected using the vehicles user interface.

Optionally, the nomadic device can be used to display vehicle information while walking around a parked vehicle.
Telephony and SMS

- Transfer of recipient list from ND to vehicle
- Initiation of ND phone call by driver from vehicle HMI
- Voice dialing using Nuance Speech Recognition system
- Signaling of incoming ND phone call via vehicle HMI
- Blocking of incoming ND actions from signaling due to DVE state or other ongoing outputs of higher priority.
- Hands free phone conversation via in-vehicle microphone
- Allow the ND to receive an SMS and display it through vehicle HMI
- Display the total number of unread SMS messages from ND.
Music and Calendar

- Transfer of song list from ND to vehicle HMI
- Control of ND song playback by driver from vehicle HMI
  - Choosing song to play
- Play/pause/stop
- Streaming of audio from ND to in-vehicle speakers, via vehicle HMI HW
- Blocking by muting music from ICA signaling due to DVE state or other ongoing outputs of higher priority
- Transferring calendar reminders (or tasks) from the ND to the vehicle.
- ND calendar reminders from signaling due to DVE state or other
Driver can stand at the back of the trailer and monitor loading for safe distribution.

- Bar charts move as weight on trailer changes.
- Overweight axles change slider to red as a warning to driver.
AIDE logical view of the component structure (level 1)

TOWARDS FUTURE AUTOMOTIVE HMI
AIDE final workshop and exhibition  April 15-16, 2008, Gothenburg

ICA

DVE
DVEM  PM

Sensors

Nomad Device Gateway

I/O Device Control

Application 2 UI

View Graphic  View Haptic  View Speech

Application 2

AIDE Interface Adapter  Application Model

Gadget Node

Gadget Node “ND Gateway”

AIDE Gadget BT/Other Standard BT

www.aide-eu.org
AIDE Gadget Architecture

TOWARDS FUTURE AUTOMOTIVE HMI

AIDE Gadget Node

Condition Server Gadget

Interaction Manager Gadget

Moderator Gadget

Sensor Data

Music Source Gadget

Cell Phone Gadget

Moderator Gadget

Bluetooth

UDP/IP

802.11

802.15

RS232 serial
The AIDE Gadget Packet Delivery Profile (GPDP) ensures interoperability between the Bluetooth devices for exchanging Gadget packets. This ensures the devices to form an Ad-hoc network called Gadget Network (GN).

- Each device may host one or more Gadget services in its application domain.
- Any Gadget device in the network can discover, utilize and control the Gadget services provided by the Gadget devices in the network.

AIDE Gadget BT represents a simple way to send asynchronous packets with single commands (for instance, a Cellphone Hang-up) to these various Gadget services.

- Examples of these Gadget services would be an
  - Address Book or Email services on a PDA,
  - Driver Advocate and Navigation System services on Automobile
  - Contact List on a Mobile Phone.
Ways to consider Gadget Bluetooth:

- If you think of all the standard Bluetooth profiles (hands-free, OBX, or MP3 audio) as vertical stacks, then Gadget BT is a horizontal slice attaching to them all, allowing intelligent coordination of the multiple and simultaneous BT profiles.

Another way to explain how Gadget BT operates would be to imagine a TV or DVD player setup, where the normal BT profiles act as the ‘devices and wires’ and Gadget is the ‘remote control’ that can mute the sound or change channel.
The Key Features of Gadget BT

- **Lightweight** – to be applied to very small devices; the minimal AIDE BT node is fully implemented with a few hundred lines of code, and the most complex one is just a few thousand.
- **Transport protocol neutral** -- can run on Bluetooth, UDP/IP, 802.11, 802.15, or even RS232 serial.
- **Asynchronous and non mandatory** -- messages can arrive at any time and the gadget is free to implement or ignore any request, its only requirement is to return a yes or no answer to all requests (an implied 'no' is assumed if no answer at all).
- **Seamless** -- all services can change and or move at any time, clients must negotiate all requests and be prepared have different levels of service.
- **Connectionless** -- messages are exchanged through an implied 'always on' packet backchannel, i.e. no pairing or prearrangement.
- **Processor/language neutral** -- all messages are UTF8 character strings; the only API is 'sendMessage' and 'processMessage' to handle a single character string.
- **Simple flat address scheme** -- no complex identifications, no unique paths, all messages are sent to generic 'gadgets' that are currently in the range of the user, i.e. the 'car' sends a "don't ring now" or a "current speed is 55kph" message to the ‘cellphone’, where the cellphone can use this information to do a better job of the BT hands-free profile.
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Additional Reference Slides
AI DE nomadic gateway architecture (goal)

AIDE Nomadic Device Gateway

AIDE system

ICA/DVE

Music Sink

ASR/TTS

HMI (Dialog Manager)

Moderator

Workload Manager

Condition Server

CAN: AIDE/NDGP

Bluetooth: Gadget

Cell Phone

Music Source

Application(s)
<table>
<thead>
<tr>
<th>Gadget Type</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moderator</td>
<td>The Moderator is responsible for maintaining the list of all current Gadgets services in a Bluetooth Gadget Network and to process enlist and resign operations (addition and removal of Gadget services). Its main responsibility is handling cases with multiple Gadgets of the same type, to pick the ‘active’ one or to construct a composite Gadget or service (e.g. if two ‘phonebook’ services are currently in the net it presents one interface to the contents of both).</td>
</tr>
<tr>
<td>Workload Manager</td>
<td>This Gadget service is responsible to queue all output messages to the user and delivering them at ‘the right time and right way’. It is also the manager that maintains the current task queue and implements the policy of how many and what modality tasks can use.</td>
</tr>
<tr>
<td>Condition Server</td>
<td>Provides ‘context’ to other Gadgets by maintaining the current condition of all available sensors Produces current condition trees to group sensor ‘conditions’ in to manageable related groups Has above information in ‘Condition Value State’ tuples for ‘numeric values and ‘Condition State’ tuples for categorical values The information describes current external, ‘real world’ context for all the Gadgets network so they can customize their services</td>
</tr>
</tbody>
</table>
## Gateway Commands for Phone

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full name</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDP</td>
<td>Nomadic device present</td>
<td>A nomadic device is/has connected</td>
</tr>
<tr>
<td>NDA</td>
<td>Nomadic device absent</td>
<td>A nomadic device is/has disconnected</td>
</tr>
<tr>
<td>RNDS</td>
<td>Request Nomadic device status</td>
<td>Request nomadic status -- reply with a NDP or NDA</td>
</tr>
<tr>
<td>IPCR</td>
<td>Incoming phone call request</td>
<td>There is an incoming phone call on a connected phone</td>
</tr>
<tr>
<td>PCNV</td>
<td>Phone call no longer valid</td>
<td>The other part in the phone call has hung up, or the user has hung up using the &quot;No&quot; button on the handheld device.</td>
</tr>
<tr>
<td>RPCS</td>
<td>Request phone call status</td>
<td>query phone for current call status -- reply with PCS</td>
</tr>
<tr>
<td>PCS</td>
<td>Phone call status</td>
<td>possible values: inACall[:&lt;number&gt;][:&lt; caller_id&gt;]], onHold, ringing, dialing, none -- this is sent on each state change or in response to a RPCS</td>
</tr>
<tr>
<td>RPB</td>
<td>Request phone book</td>
<td>Request of phone book entry(s) -- reply with PBE (if exact match) or PBL is more than one match</td>
</tr>
<tr>
<td>PBL</td>
<td>Phone book name list</td>
<td>Phone book list of names that match the RPB pattern</td>
</tr>
<tr>
<td>PBE</td>
<td>Phone book entry</td>
<td>A Vcard with detail contact information</td>
</tr>
<tr>
<td>PCY</td>
<td>Phone call yes</td>
<td>The user has accepted an incoming phone call using the vehicle HMI.</td>
</tr>
<tr>
<td>PCN</td>
<td>Phone call no</td>
<td>The user has denied or ended a phone call using the vehicle HMI.</td>
</tr>
<tr>
<td>OPCR</td>
<td>Outgoing phone call request</td>
<td>The user has initiated a phone call using the in-vehicle HMI.</td>
</tr>
<tr>
<td>SMS</td>
<td>Short Message Service</td>
<td>Display an incoming SMS text</td>
</tr>
<tr>
<td>PCH</td>
<td>Phone Call Hold</td>
<td>put the phone call on hold (or take off hold)</td>
</tr>
</tbody>
</table>
Gateway commands for other Devices

**Music Player**
- **MP_RSL**  Request song list  Request of song list -- reply with many MP_SI
- **MP_CS**  Choose song  User choice of song
- **MP_C**  Command  play/Pause/stop/FF/REW
- **MP_SI**  Song Information  Includes: ID, artist, album, song, length
- **MP_PIS**  Position in song  Sent about twice a second (note from Bob, not sure this is avail in A2DP to be sent)

**Calender**
- **CR_DR**  Display request  Nomadic device wants to display a calendar reminder
- **CR_C**  Command  Reply to reminder, E.g. dismiss/snooze, possibly including time of snooze. Incl ID.

**Context Server**
- **USV**  Update Sensor Value  update the published value of a named sensor with this value
- **RSV**  Request Sensor value  request the current value of a named sensor - reply with a USV
- **OSV**  Override Sensor value  request overriding current sensor value for x milli-seconds
- **RNS**  Request Sensor Names  request the names of all sensors in the current system - reply with 1 or more SI
- **SI**  Sensor Information  return sensor name and optional precision, range and unit info

**General Status**
- **NDG_PING**  request a response if still operational
- **HMI_PING**  reply if operational
- **NDG_OK**  text message response, if there was an error
- **HMI_OK**
- **NDG_ERR**
- **HMI_ERR**
<table>
<thead>
<tr>
<th>vectorType 0</th>
<th>ND gateway -&gt; Veh. HMI</th>
<th>Message type</th>
<th>Device_ID</th>
<th>Argument(s) chars colon separated...</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDP</td>
<td>0</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDA</td>
<td>1</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPCR</td>
<td>2</td>
<td>x</td>
<td>&lt;number&gt;[&lt;callerID&gt;]</td>
<td></td>
</tr>
<tr>
<td>PCNV</td>
<td>3</td>
<td>x</td>
<td>{optional reasons why its not valid}</td>
<td></td>
</tr>
<tr>
<td>PCS</td>
<td>4</td>
<td>x</td>
<td>&lt;status&gt;</td>
<td></td>
</tr>
<tr>
<td>PBL</td>
<td>5</td>
<td>x</td>
<td>&lt;name1&gt;…&lt;nameN&gt; (limited to 1400 total chars)</td>
<td></td>
</tr>
<tr>
<td>MP_PIS</td>
<td>6</td>
<td>x</td>
<td>&lt;seconds&gt;</td>
<td></td>
</tr>
<tr>
<td>MP_SI</td>
<td>7</td>
<td>x</td>
<td>&lt;song#&gt;:&lt;title&gt;:&lt;artist&gt;:&lt;album&gt;:&lt;song length&gt;</td>
<td></td>
</tr>
<tr>
<td>CR_DR</td>
<td>8</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RSV</td>
<td>9</td>
<td>x</td>
<td>&lt;sensorName&gt;</td>
<td></td>
</tr>
<tr>
<td>OSV</td>
<td>10</td>
<td>x</td>
<td>&lt;sensorName&gt;:&lt;value&gt;:&lt;durationSec&gt;</td>
<td></td>
</tr>
<tr>
<td>RSN</td>
<td>11</td>
<td>x</td>
<td>&lt;all&gt;</td>
<td></td>
</tr>
<tr>
<td>NDP_OK</td>
<td>12</td>
<td>x</td>
<td>&lt; version info&gt;</td>
<td></td>
</tr>
<tr>
<td>HMI_PING</td>
<td>13</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PBE</td>
<td>14</td>
<td>x</td>
<td>Vcard (for the single name phone book entry) (limited to 1400 total chars)</td>
<td></td>
</tr>
<tr>
<td>SMS</td>
<td>15</td>
<td>x</td>
<td>&lt;from&gt;:&lt;text of the message&gt;</td>
<td></td>
</tr>
<tr>
<td>NDG_ERR</td>
<td>16</td>
<td></td>
<td></td>
<td>&lt;text of error reponse to one of the below (HMI) requests&gt;</td>
</tr>
<tr>
<td>Message</td>
<td>Message type</td>
<td>Device ID</td>
<td>Argument(s) ASCII chars colon separated...</td>
<td></td>
</tr>
<tr>
<td>---------</td>
<td>--------------</td>
<td>-----------</td>
<td>-------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>USV</td>
<td>0</td>
<td>x</td>
<td>sensorName:newValue</td>
<td></td>
</tr>
<tr>
<td>RPB</td>
<td>1</td>
<td>x</td>
<td>&lt;name template&gt;:{Home</td>
<td>Cell</td>
</tr>
<tr>
<td>PCY</td>
<td>2</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCN</td>
<td>3</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPCR</td>
<td>4</td>
<td>x</td>
<td>&lt;number OR name&gt;</td>
<td></td>
</tr>
<tr>
<td>MP_RSL</td>
<td>5</td>
<td>x</td>
<td>all</td>
<td>num</td>
</tr>
<tr>
<td>MP_CS</td>
<td>6</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MP_C</td>
<td>7</td>
<td>x</td>
<td>p=play, P=pause/resume, s=stop, F=FFWD, R=RWD</td>
<td></td>
</tr>
<tr>
<td>CR_C</td>
<td>8</td>
<td>x</td>
<td>Snooze = 0 Dismiss = 1</td>
<td></td>
</tr>
<tr>
<td>RPCS</td>
<td>9</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RNDS</td>
<td>10</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HMIR</td>
<td>11</td>
<td>x</td>
<td>&lt;reply status&gt;</td>
<td></td>
</tr>
<tr>
<td>SI</td>
<td>12</td>
<td>x</td>
<td>&lt;sensorName&gt;:N</td>
<td>C:&lt;state1&gt;:...:&lt;stateN&gt;{:&lt;unit&gt;:&lt;minval&gt;:&lt;maxval}&gt;</td>
</tr>
<tr>
<td>HMI_OK</td>
<td>13</td>
<td>x</td>
<td>&lt;version info&gt;</td>
<td></td>
</tr>
<tr>
<td>NDG_PING</td>
<td>14</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCH</td>
<td>15</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HMI_ERR</td>
<td>16</td>
<td>x</td>
<td>&lt;text of error reponse to one of the above (NDG) requests&gt;</td>
<td></td>
</tr>
<tr>
<td>SEND_SMS</td>
<td>17</td>
<td>x</td>
<td>&lt;to&gt;:&lt;message&gt;</td>
<td></td>
</tr>
</tbody>
</table>
Case 2a: Incoming call: AIDE (at unsafe time)

Music Source -> Cell Phone -> Condition Server -> Music Sink

Nomadic Gateway/Workload Manager

HMI App

ICA

Real I/O

User

gadgetName("WorkloadManager")

socket

incomingCall:123-4567

wait:3

Hung up

Caller gives up OR goes to voice mail

3 seconds pass...

IPRC(ID)

ARV

VR(D)

HMIR(D)

PCNV(ID)

Note: the gateway knows its a state based ICA implementation simply remembers the previous decision and re-transmits

From DVE: Traffic Bad

www.aide-eu.org
Case 4a: Place call: AIDE (we hangup)
Case 5: Sensor Update: AIDE (any time)

Music Source <-> Gadget Messages -> Nomadic Gateway/Workload Manager <-> AIDE Vectors -> User

Cell Phone

Node

Condition Server

Moderator

Music Sink

HMI App

ICA

Real I/O

USV(message:weight1R:8)

updateCondition:weight1R:8

Consults subscription list

update:weight1R:8

from DVE: Axel

weight sensor changes

Phone display

Updates

www.aide-eu.org
Case 6: get song list: AIDE (any time)

HMI

App

ICA

Real I/O

Music Source

Cell Phone

Node

Condition Server

Moderator

Music Sink

Nomadic Gateway/Workload Manager

HMI App

ICA

Real I/O

User

Update song list display

... and so on

songInfo:1:What a Wonderful World:Louis Armstrong::2.09

getSongs:a

songInfo:2:I got You Babe:Sonny & Cher:Greatest Hits:3.11

songInfo:29:Boulevard of Broken Dreams:Green Day:International Superhits:2.43

MP_RSL:all
getsongs:a

MP_SI: ...

Update song list display

display

<-- AIDE Vectors -->

<- Gadget Messages -->
Case 7: play a song: AIDE (any/safe time?)

Music Source <-> Gadget Messages <-> HMI App

Node <-> Condition Server <-> Moderator <-> Music Sink

Nomadic Gateway/Workload Manager <-> HMI App <-> ICA <-> Real I/O

User

Music Source
Cell Phone
Node
Condition Server
Moderator
Music Sink
Nomadic Gateway/Workload Manager
HMI App
ICA
Real I/O
User

Source and sync use A2DP to setup normal Bluetooth streaming

playSong:2:I got You
Babe

Source and sync use A2DP to pause streaming

pause

Source and sync use A2DP to resume streaming

play

Song ends...

Picks song from list...

Hits pause button

Hits play button
ICA simulator for rapid prototyping