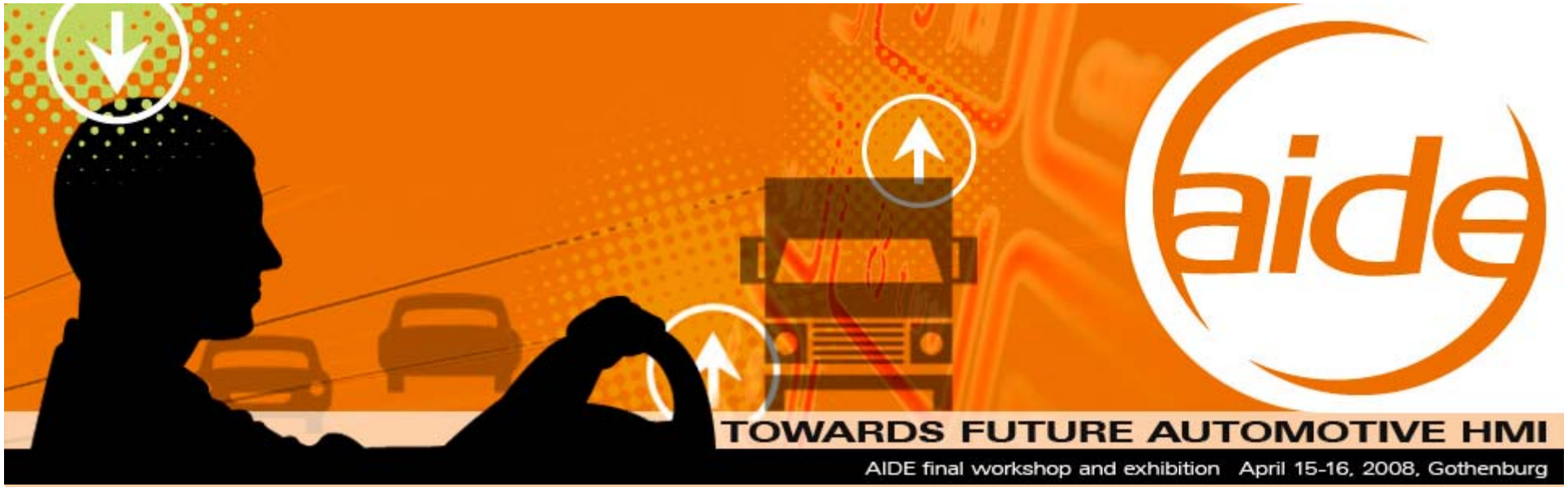


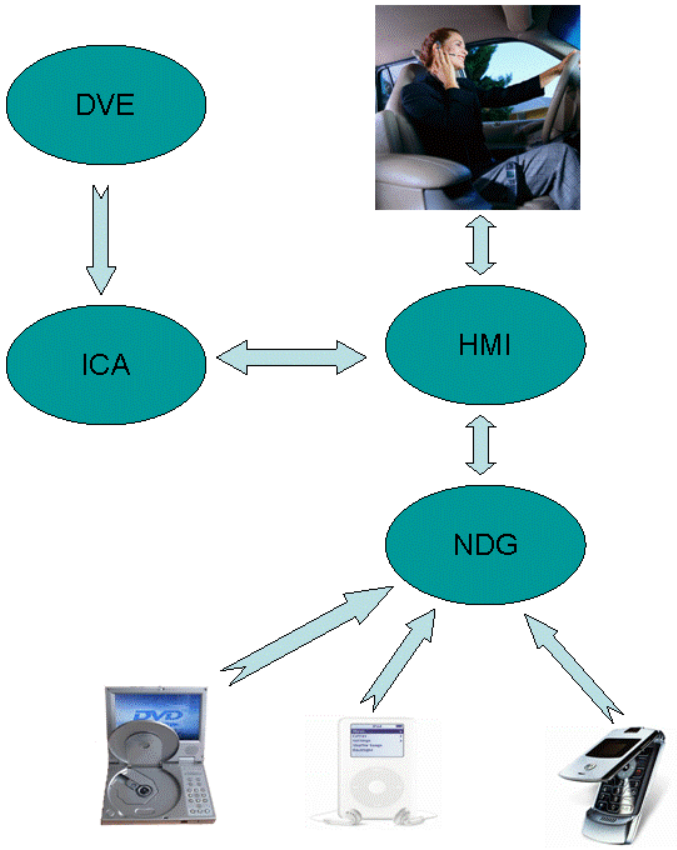
Nomadic Device Integration in AIDE

Mike Gardner - Motorola

Nomadic Device Gateway Summary

- 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.

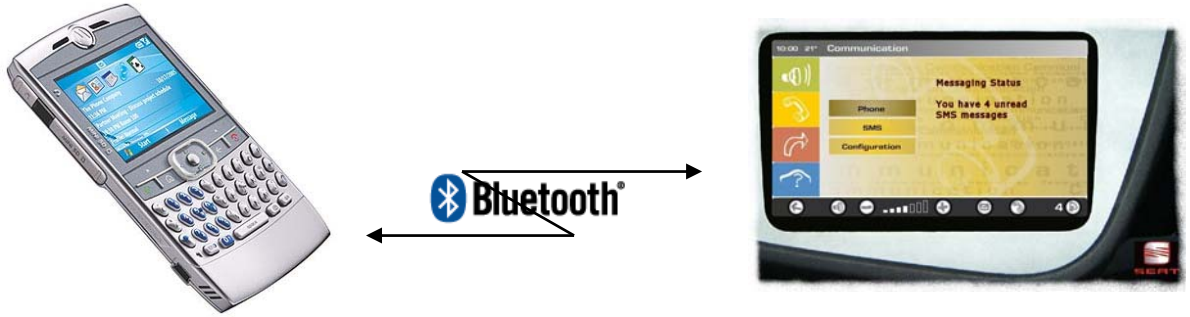
Nomadic Device Gateway Philosophy



- 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

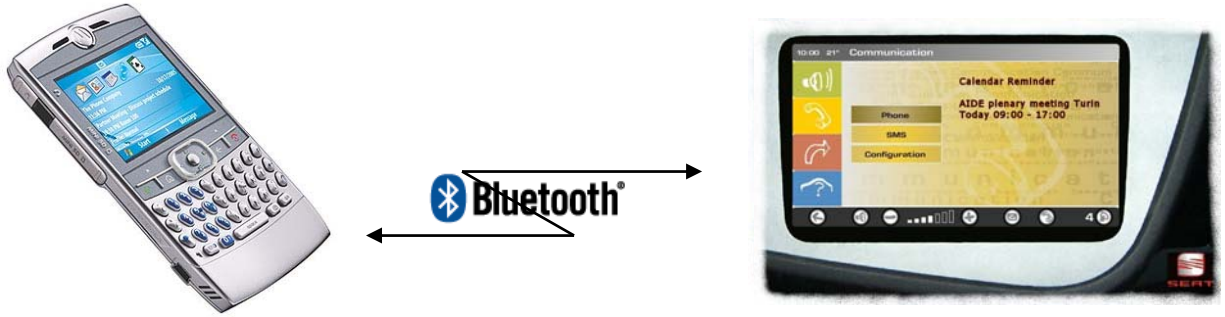
Telephony and SMS

- 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

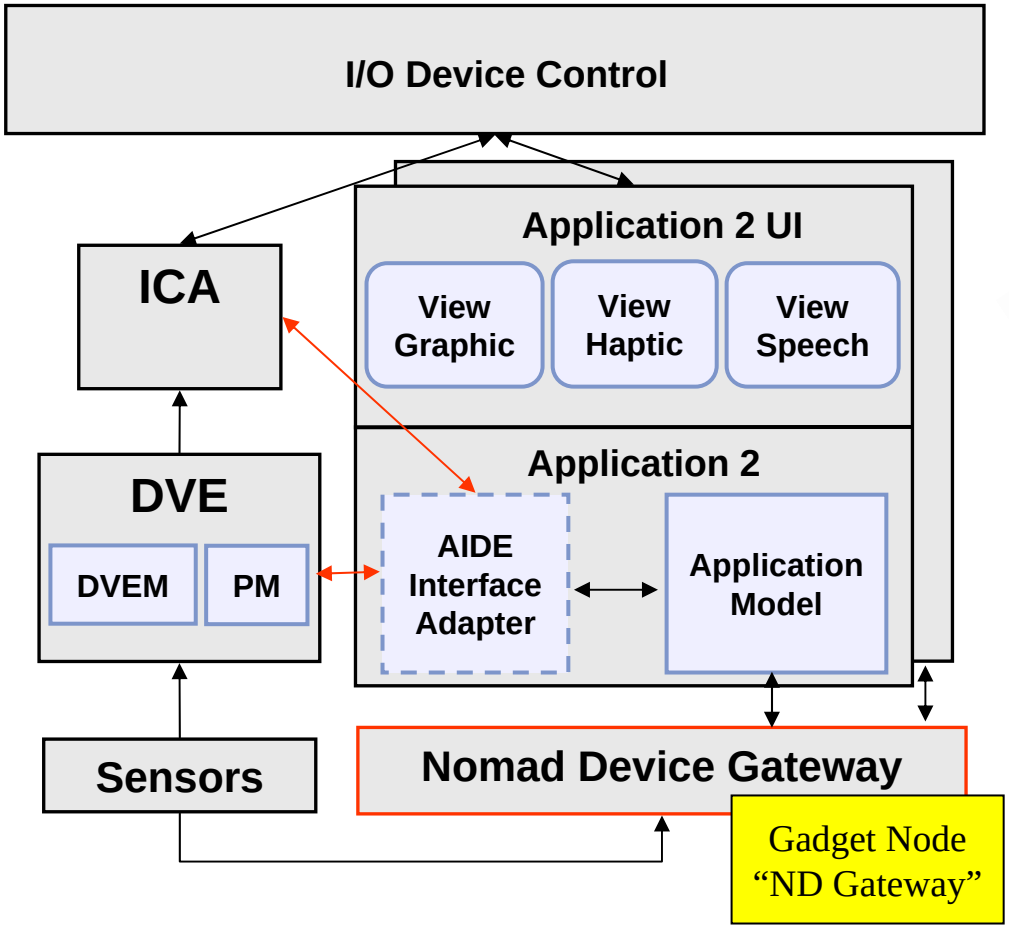
- Transfer of song list from ND to vehicle HMI
- Control of ND song playback by driver from vehicle HMI
  - Choosing song to play
- Play/pause/stop
- Streaming of audio from ND to in-vehicle speakers, via vehicle HMI HW
- Blocking by muting music from ICA signaling due to DVE state or other ongoing outputs 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



Fleet Productivity: Truck Axle Loading

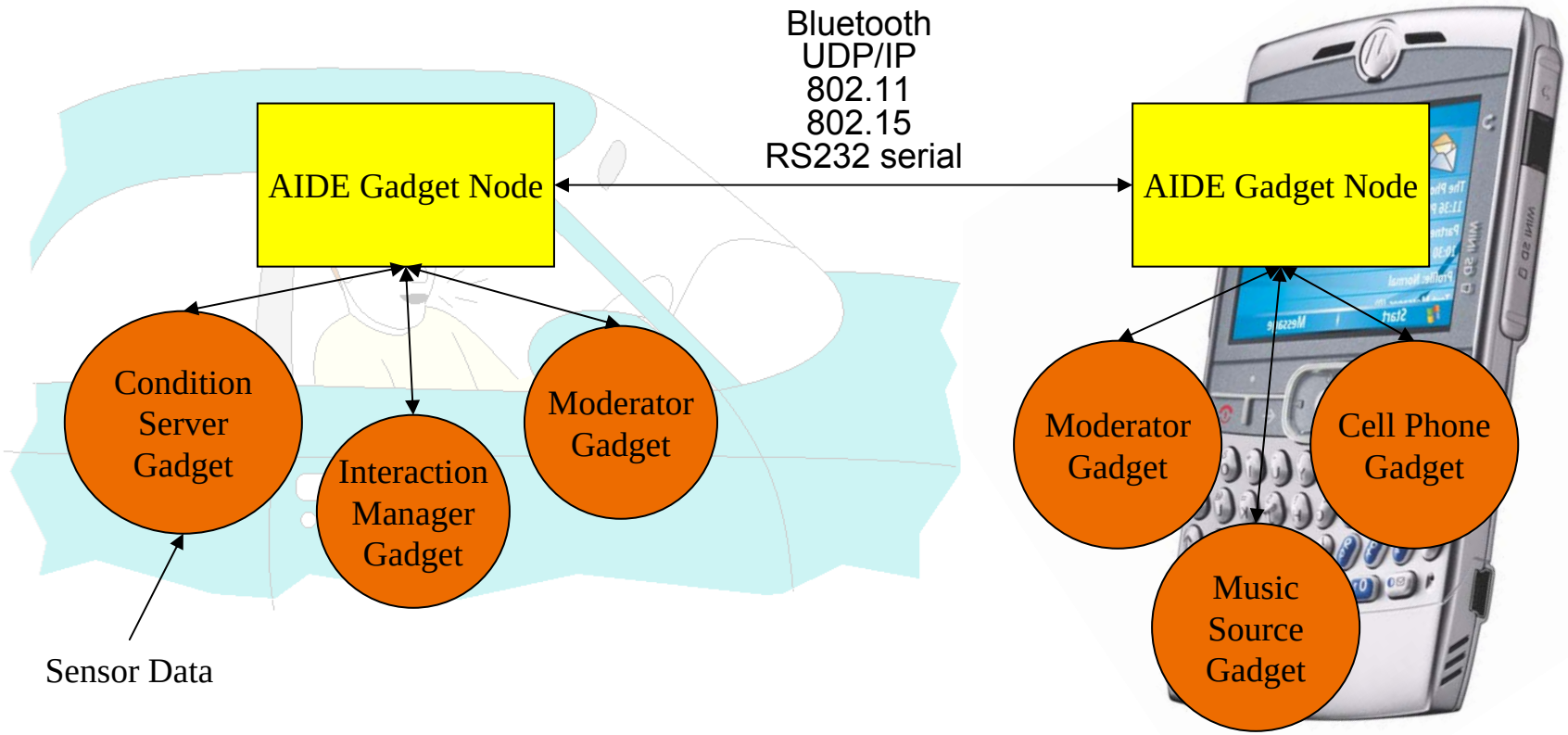
- Driver can stand at the back of the trailer and monitor loading for safe distribution.
  - Bar charts move as weight on trailer changes.
  - Overweight axles change slider to red as a warning to driver.

AIDE logical view of the component structure (level 1)



AIDE Gadget BT/
Other Standard BT

AIDE Gadget Architecture



An Overview of Gadget Bluetooth

- The AIDE Gadget Packet Delivery Profile (GPDP) ensures interoperability between the Bluetooth devices for exchanging Gadget packets. This **enables 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.

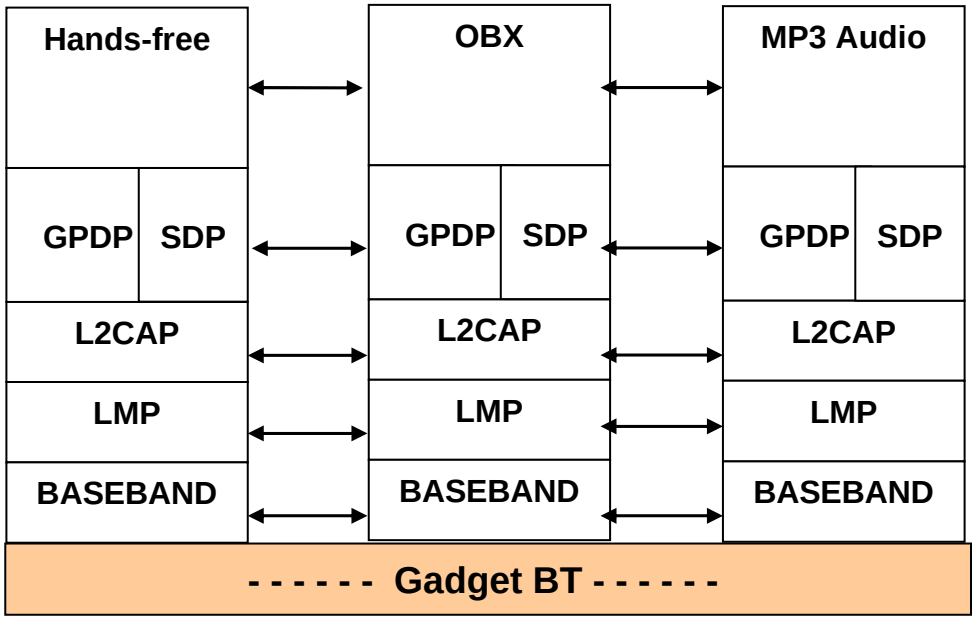
Gadget BT Devices

An Overview of Gadget Bluetooth (continued…)

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 co-ordination of the multiple and simultaneous BT profiles**.

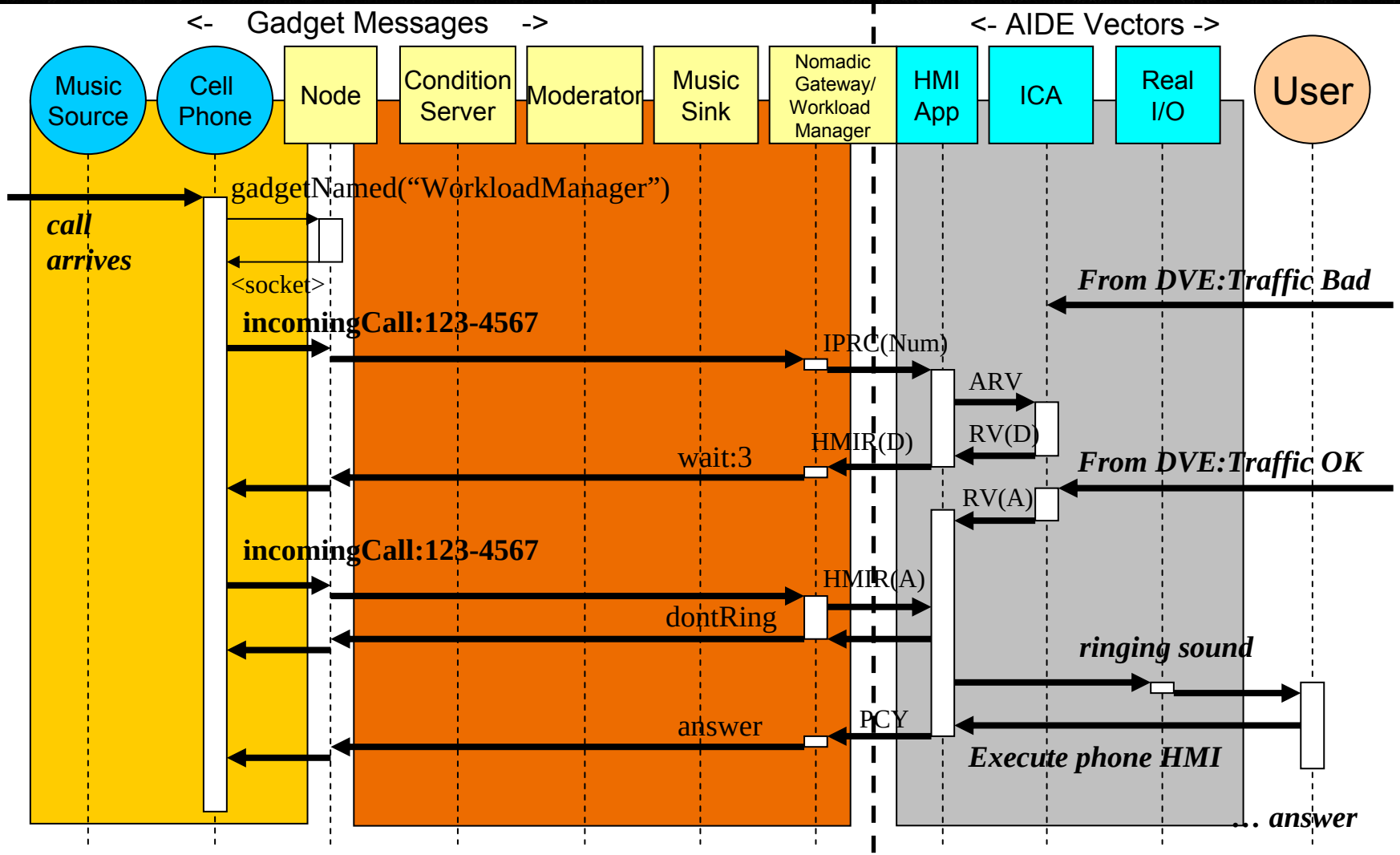
  Another way to explain how Gadget BT operates would be to imagine a TV or DVD player setup, where the normal BT profiles act as the 'devices and wires' and ***Gadget is the 'remote control'*** *that can mute the sound or change channel.*



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.

Ladder Diagram for Incoming Call (Case 2b: unsafe->safe)



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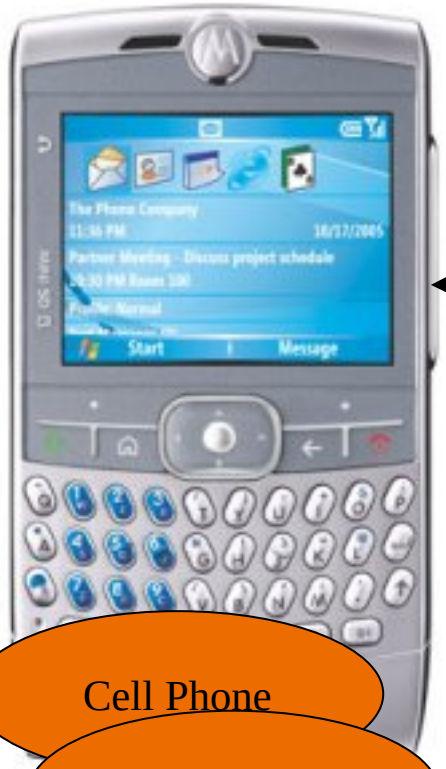
Additional Reference Slides

AIDE nomadic gateway architecture (goal)

A Nomadic Device

Nomadic Device Gateway (NDG)

AIDE system



Bluetooth: Gadget

CAN: AIDE/ NDGP

Cell Phone

Music Source

Application (s)

Moderator

Workload Manager

Condition Server

ICA/DVE

Music Sink

ASR/TTS

HMI (Dialog Manager)

AIDE nomadic gateway architecture

Gadget Type	Purpose
Moderator	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).
Workload Manager	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.
Condition Server	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

Gateway Commands for Phone

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

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 inA2DP 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	
NDG_OK	reply if operational
HMI_OK	
NDG_ERR	text message response, if there was an error
HMI_ERR	

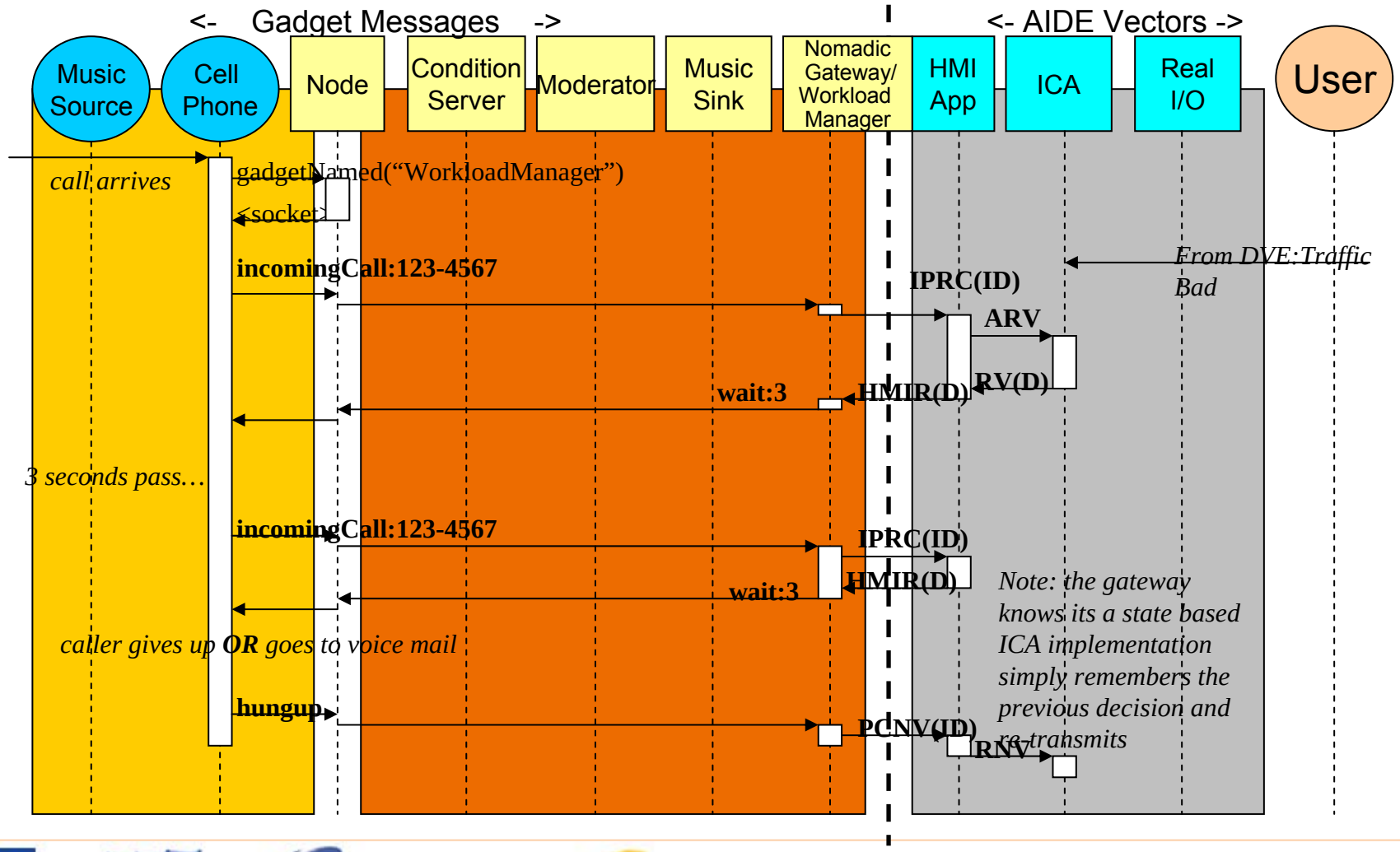
Messages from NDG to HMI

vectorType 0	ND gateway -> Veh. HMI		
Message	Message type	Device_ID	Argument(s) chars colon separated...
NDP	0	x	
NDA	1	x	
IPCR	2	x	<number>[:<callerID>]
PCNV	3	x	{optional reasons why its not valid}
PCS	4	x	<status>
PBL	5	x	<name1>:…<nameN> (limited to 1400 total chars)
MP_PIS	6	x	<seconds>
MP_SI	7	x	<song#>:<title>:<artist>:<album>:<song length>
CR_DR	8	x	
RSV	9	x	<sensorName>
OSV	10	x	<sensorName>:<value>:<durationSec>
RSN	11	x	<all> | <starts with>
NDG_OK	12	x	< version info>
HMI_PING	13	x	
PBE	14	x	Vcard (for the single name phone book entry) (limited to 1400 total chars)
SMS	15	x	<from>:<text of the message>
NDG_ERR	16		<text of error reponse to one of the below (HMI) requests>

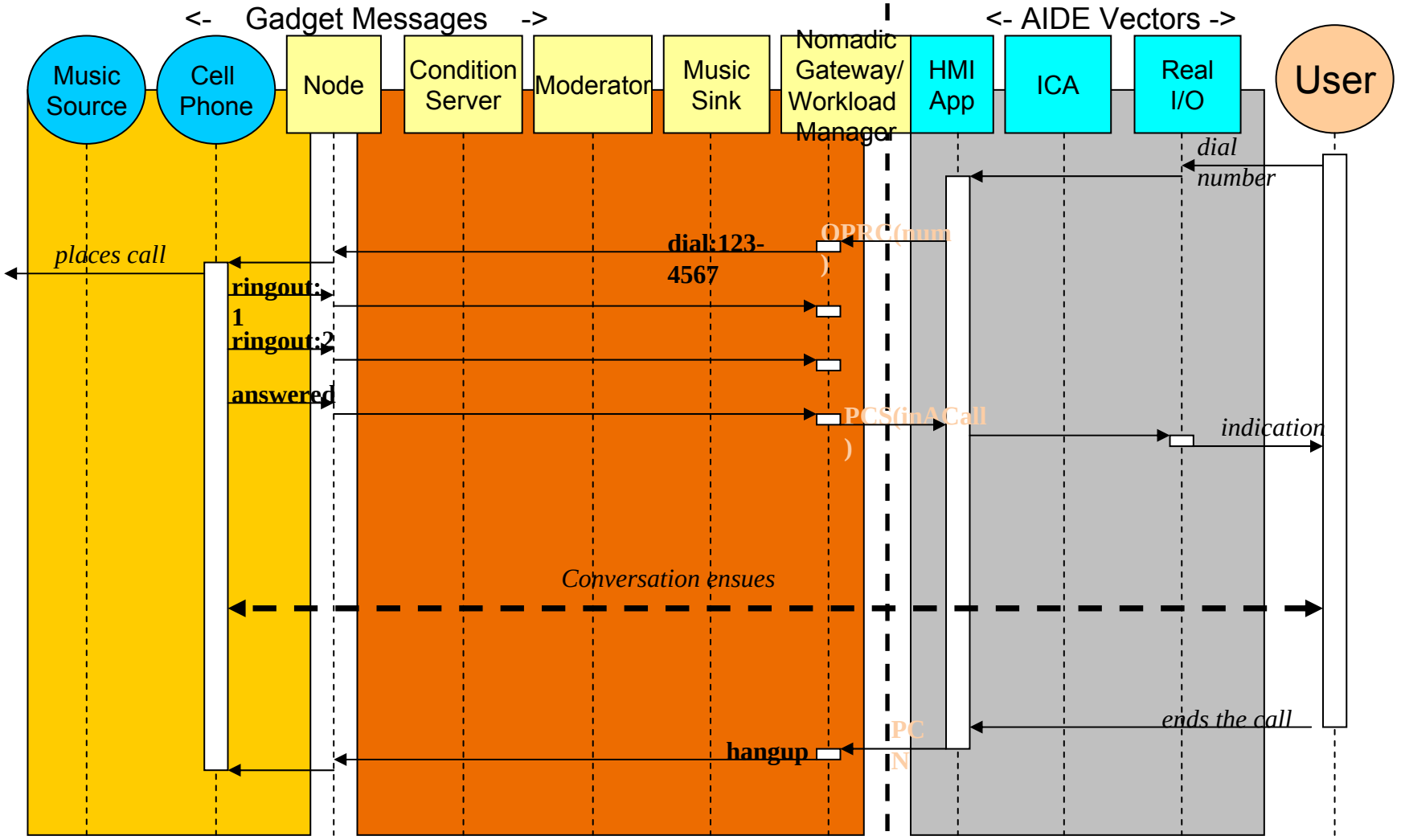
Messages from HMI to NDG

vectorType 1	Veh. HMI -> ND gateway		
Message	Message type	Device_ID	Argument(s) ASCII chars colon separated...
USV	0	x	sensorName:newValue
RPB	1	x	<name template>{:Home|Cell|Work}
PCY	2	x	
PCN	3	x	
OPCR	4	x	<number OR name>
MP_RSL	5	x	all | num | fromNum-toNum>
MP_CS	6	x	
MP_C	7	x	p=play, P=pause/resume, s=stop, F=FFWD, R=RWD
CR_C	8	x	Snooze = 0 Dismiss = 1
RPCS	9	x	
RNDS	10	x	
HMIR	11	x	<reply status>
SI	12	x	<sensorName>:N|C:<state1>:…:<stateN>{:<unit>:<minval>:<maxval>}
HMI_OK	13	x	<version info>
NDG_PING	14	x	
PCH	15	x	
HMI_ERR	16		<text of error reponse to one of the above (NDG) requests>
SEND_SMS	17	x	<to>:<message>

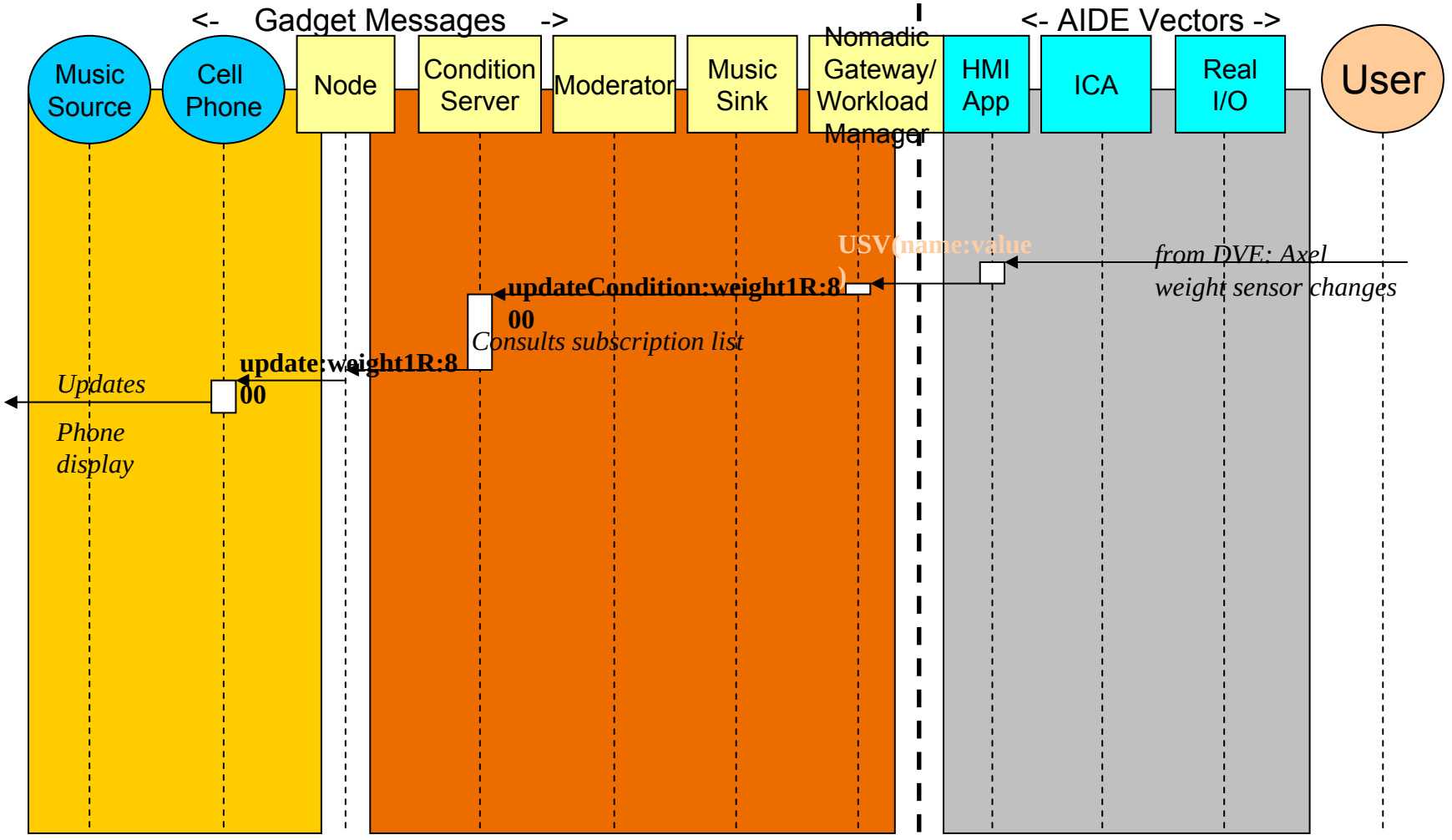
Case 2a: Incoming call: AIDE (at unsafe time)



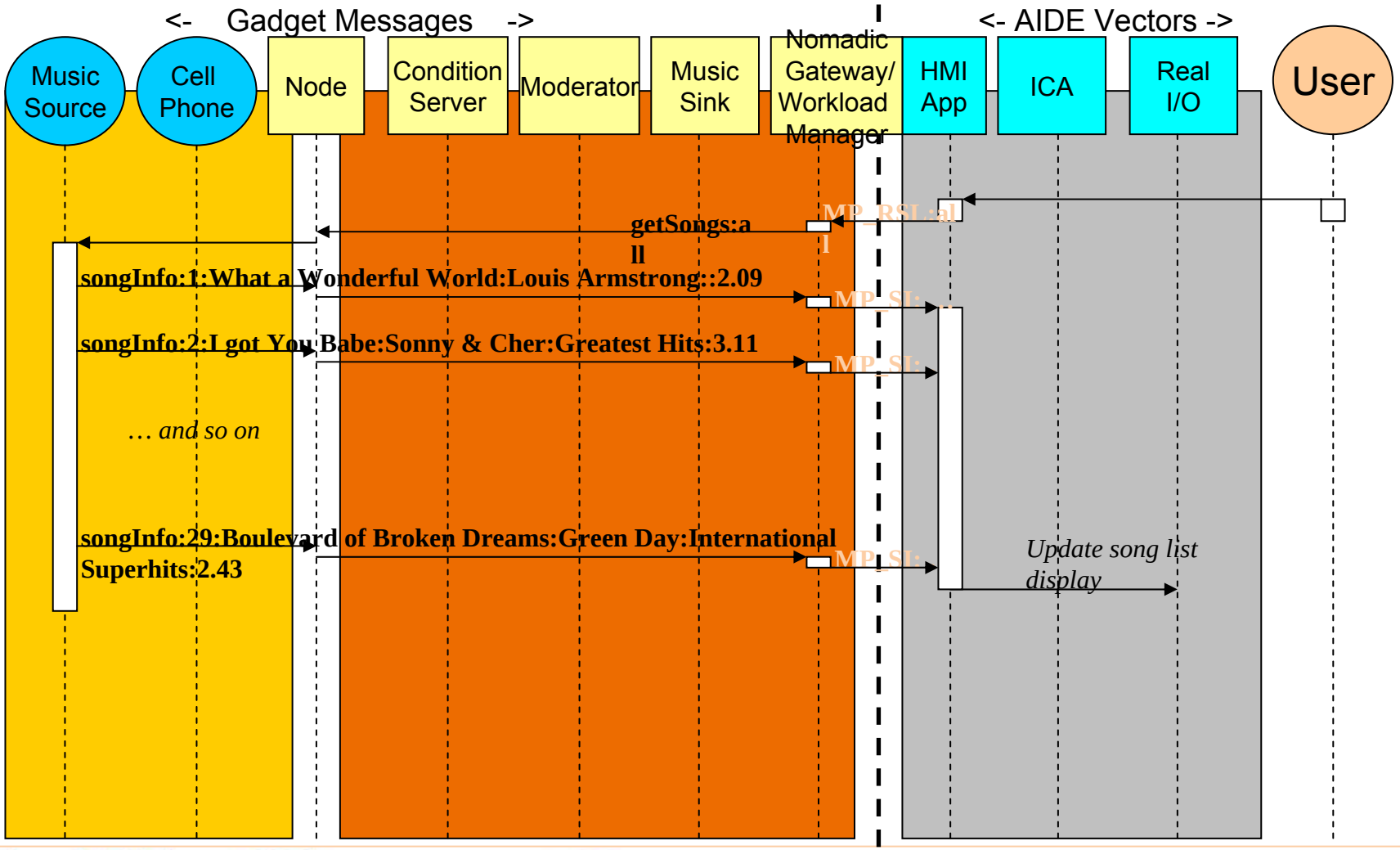
Case 4a: Place call: AIDE (we hangup)



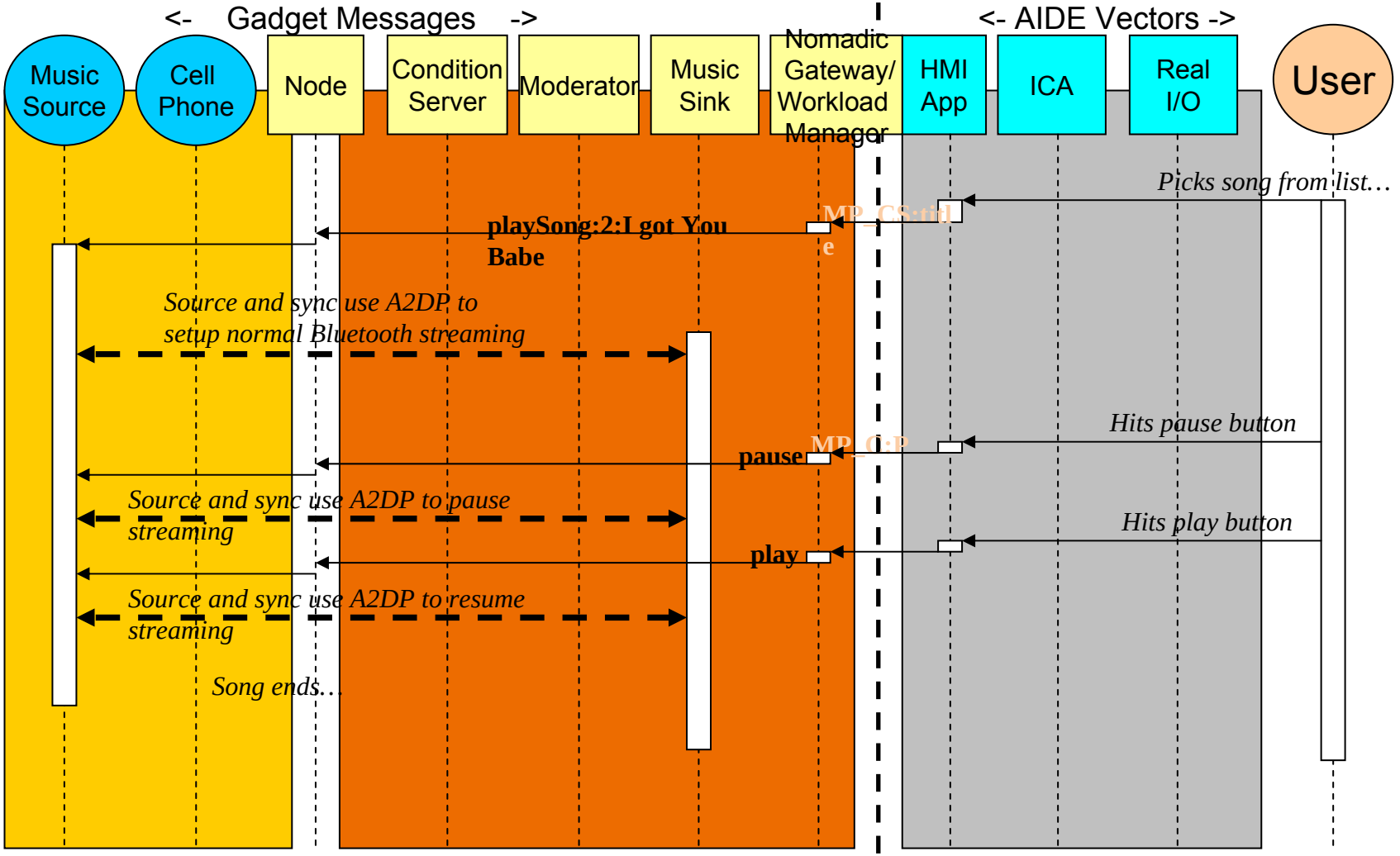
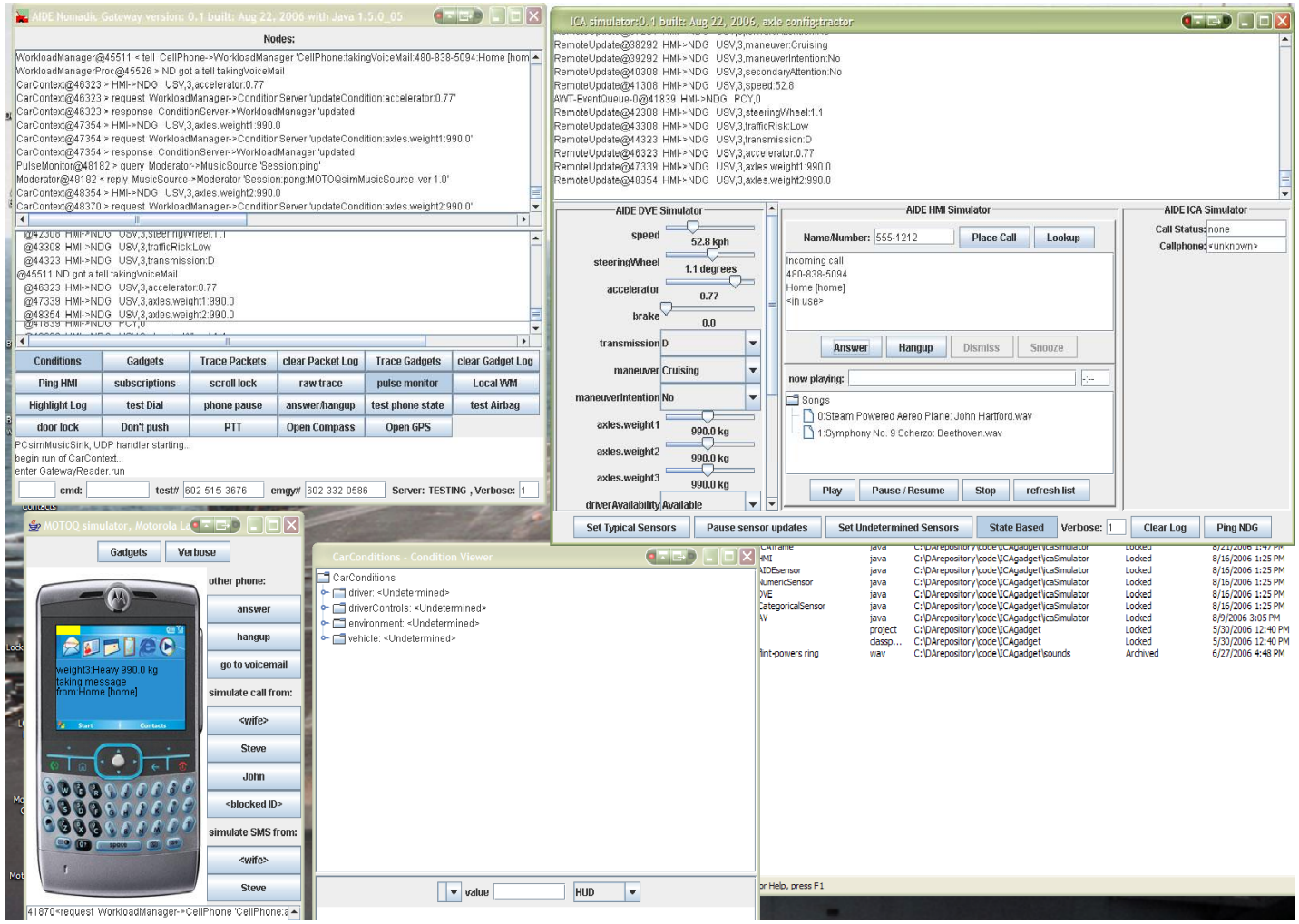
Case 5: Sensor Update: AIDE (any time)



Case 6: get song list: AIDE (any time)



Case 7: play a song: AIDE (any/safe time?)



ICA simulator for rapid prototyping