

Development of IT Cluster

(Multi-information DVD Navigation System for DAIHATSU MOTOR CO., LTD.)

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Abstract

With the popularization of mobile telephones, there continues to be a growing number of products that are equipped with information technology (IT) functions. This includes products for in-car equipment. And because of the tendency to emphasize economy, the ratio of such products made for subcompact and compact vehicles is high. For this reason we developed this product (IT cluster), which is equipped with IT functions such as i-mode, Internet, e-mail, and HELPNET, and which connects to a mobile telephone, using a display developed for a subcompact-vehicle genuine parts line. This is the first IT-function-equipped product that Fujitsu Ten has developed for a genuine display developed for a subcompact vehicle. It includes Internet and i-mode browsers that ensure the required in-car quality and provide much better stability (= quality) than a browser used as a personal computer application. Moreover, an easy-to-understand user interface has been adopted. This feature ensures that the product is very simple to use, even by someone who normally does not operate a PC. On top of this, since the i-mode and car navigation systems are linked together, location information can be sent and received, map searches can be performed, and support can be given for i-NaviLink that enable destinations to be set up.

1

Introduction

Our company strives to create "car infotainment" products, the aim of which is to provide the information and entertainment required of an automobile. As an initial step, this report introduces the recently developed "IT cluster," an in-car IT information terminal product that is equipped with full-scale network connection functions. One prominent feature is that it secures in-car quality suitable for the genuine parts line of a (Daihatsu Motor Co.) vehicle, while being equipped with a large number of IT functions. The features of these built-in IT functions and the measures that were taken to secure in-car quality are described hereinafter.

2

Product overview

Display unit

- 5.8-inch wide TFT display
- Touch panel control
- Three character font sizes (8 × 8, 12 × 12, 16 × 16 dot)
- Broadcast station name display (radio/TV)
- Clock function
- Hands-free (built-in microphone)
- Address book (1000 items: supporting retrieval from mobile phone)
- Internet connection
- i-mode
- Browser (HTML/C-HTML)
- E-mail (transmit/receive messages)
- Support for i-NaviLink
- HELPNET
- Corner monitor input
- Air-conditioning control

Audio unit

- AM/FM tuner
- CD (CD-Text support) or MD (title display support)
- 35W × 4-ch power amplifier
- Hazard switch, re-circulated air/fresh air switch, front defrost switch
- Steer shift switch (can set to MOVE only)

System upgrades

- DVD navigation
- TV tuner
- ETC
- VICS
- CD changer
- VTR adapter
- Corner monitor

Table 1 Number of IT function settings

Restricted Items		Number of items
i-mode	Received mail	100
	Transmitted mail	20
	Request	20
	Free	20
	Screen memo	5
	Bookmark	20
	History	20
	Signature	1
	Mail address designation	To : 1
Internet	Received mail	10
	Transmitted mail	10
	Bookmark	20
	History	20
	Signature	1
	Mail address designation	To : 5 Cc : 10
Common	Standard format	50
	Telephone call log	Rewritable : 20 Non rewritable : 30 Transmit : 20 Receive : 20

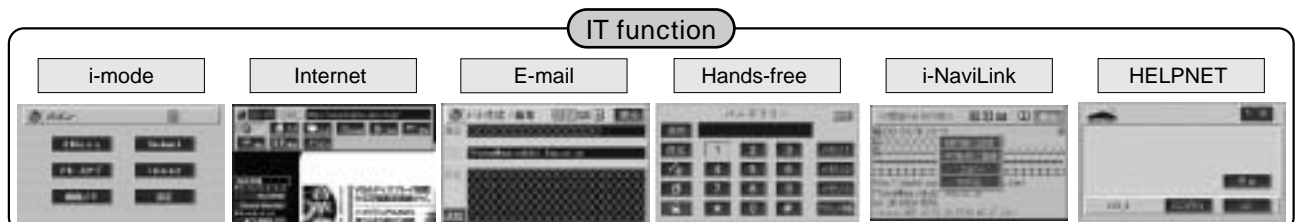
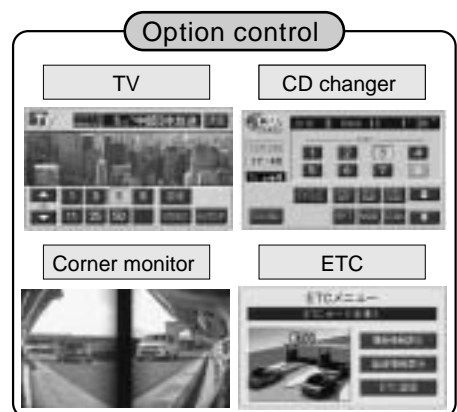
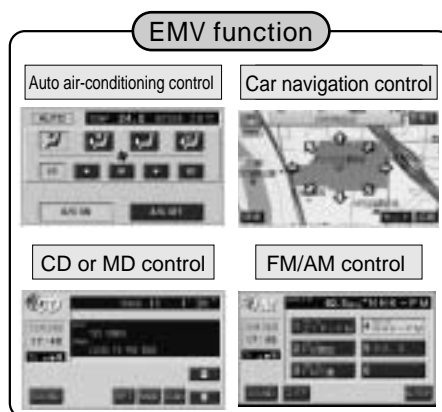


Fig.1 IT cluster entertainment

2.1 Product lineup

Common circuits and software were developed for the two vehicle types MOVE and MIRA. Only the designs were created separately.



Fig.2 Product lineup

3 Aims of development

This car infotainment product, which is the first such product developed by Fujitsu Ten,

is equipped with full-scale IT functions for the line and is significant as a trial for future product development. Moreover, as a standard display for subcompact vehicles, it is a pioneer in the industry and was developed for future market expansion.

4 In-car quality with IT functions

In order to equip in-car equipment with the IT functions of a personal computer and/or mobile telephone, it was necessary to verify that satisfactory in-car quality was attained. Measures taken are described below.

Eliminated usage difficulty by displaying easy-to-understand messages for people who do not normally use a personal computer.

Included a fail-safe function to prevent the locking and/or resetting of screens generated by the personal computer browser. Details will be given in the

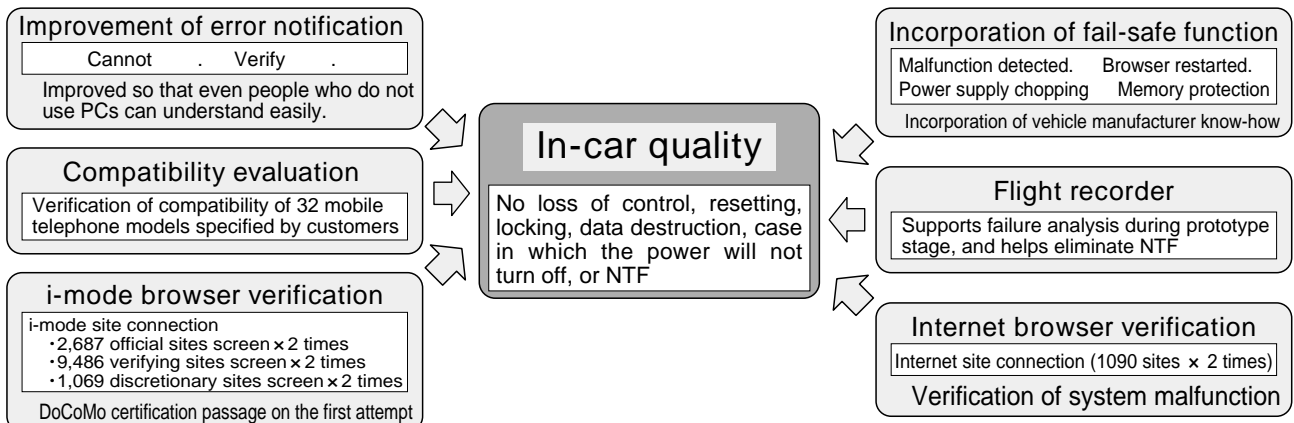


Fig.3 Actions for securing in-car quality

"Software development" section.

Installed a flight recorder, which records the status of system communications when a problem occurs, simplifies the cause analysis of a problem that occurs during the prototype stage, and eliminates design problems.

Confirmed compatibility with the 32 leading models in the mobile telephone market. (We will continue to confirm compatibility with the leading new models of next year.)

Set up a pseudo-server and verified the connection until the mobile telephone passed an actual network test. Moreover, after the actual network test was passed, verified connection to all official i-mode sites and verified connection to many Internet sites. Finally, in order to display i-mode, meets NTT DoCoMo's certification test.

Table 2 List of models confirmed to have mobile telephone compatibility

Mobile telephone company	type	Manufacturer	Model name	Date of sale
NTT Docomo	PDC	FUJITSU	F503i	2001.02
		FUJITSU	F503is	2001.08
		FUJITSU	F211i	2001.11
		NEC	N503i	2001.03
		NEC	N503is	2001.08
		NEC	N211i	2001.12
		Sony	So503i	2001.03
		Sony	So503is	2001.09
		Mitsubishi	D503i	2001.03
		Mitsubishi	D503is	2001.09
		Mitsubishi	D211i	2001.11
		Matsushita	P503i	2001.01
		Matsushita	P503is	2001.05
		Matsushita	P211i	2002.01
		FUJITSU	F504i	2002.06
		NEC	N504i	2002.06
		Mitsubishi	D504i	2002.06
Matsushita	P504i	2002.06		
au	cdmaOne	SANYO	C1001SA	2001.12
		Kyocera	C3002K	2001.12
		Matsushita	C3003P	2002.04
		Hitachi	C451H	2001.07
		Hitachi	C3001H	2001.12
J-PHONE	PDC	NEC	J - N04	2001.11
		Kenwood	J - K51	2002.01
		SANYO	J - SA04	2001.11
		Sharp	J - SH08	2002.03
		Sharp	J - SH51	2002.03
		Mitsubishi	J - D05	2001.07
		Matsushita	J - P51	2002.04
		Toshiba	J - T06	2001.07
		Toshiba	J - T51	2002.04

The P504i does not conform to the vehicle cradle because of the shape of the connector.

5 System configuration

The IT cluster system is extremely multifunctional for subcompact vehicles. With the display as the center, it controls the entire system shown in Figure 2. While an auto air conditioner is installed on the vehicle side, the air conditioner ECU is also controlled from the display. Possible options include a DVD navigation system, TV tuner, CD changer, ETC, and blind corner monitor (front left/right monitoring camera). Moreover, a video connection is available for the TV tuner, while a VICS connection is available for the navigation system. And for the control of vehicle functions, the audio unit is equipped with a hazard switch and steer shift switch (for enabling/disabling the UP/DOWN switch for the gears installed for steering).

6 Hardware

6.1 Adoption of touch panel

During the installation of the two types of browsers for i-mode and the Internet, it was necessary to adopt an on-screen keyboard that makes it easy to press on-screen links (buttons used to jump to other sites) directly and enables e-mail text and site URLs to be input in a simple manner. To achieve this objective, the adoption

of a touch panel was essential. Adopting a pressure-sensitive touch panel that had a record of performance in other lines' vehicle models has made it possible to use IT functions with ease, reduce design costs, and attain a high degree of reliability.

6.2 Development of bright TFT liquid crystal display

When a glass touch panel is installed on the front of a TFT liquid crystal display, sufficient brightness may not be obtained. (There may be a 30% drop in brightness.) To resolve this problem, a bright TFT liquid crystal display was newly developed. Optimizing the liquid crystal module structure and inverter circuit made it possible to attain a brightness of 500 cd/m² (350 cd/m² for the entire display), making the display 40% brighter than conventional models. Also, backlight costs were reduced, thanks to the adoption of an L-shaped cold-cathode fluorescent tube, which costs less than the U-shaped tubes used in conventional models.

Table 3 Comparison of brightness of 5.8-inch display screens

Condition	Conventional model	IT cluster
TFT liquid crystal unit	360	500
With touch panel	250	350
Backlight	U-shaped tube	L-shaped tube

Unit [cd/m²]

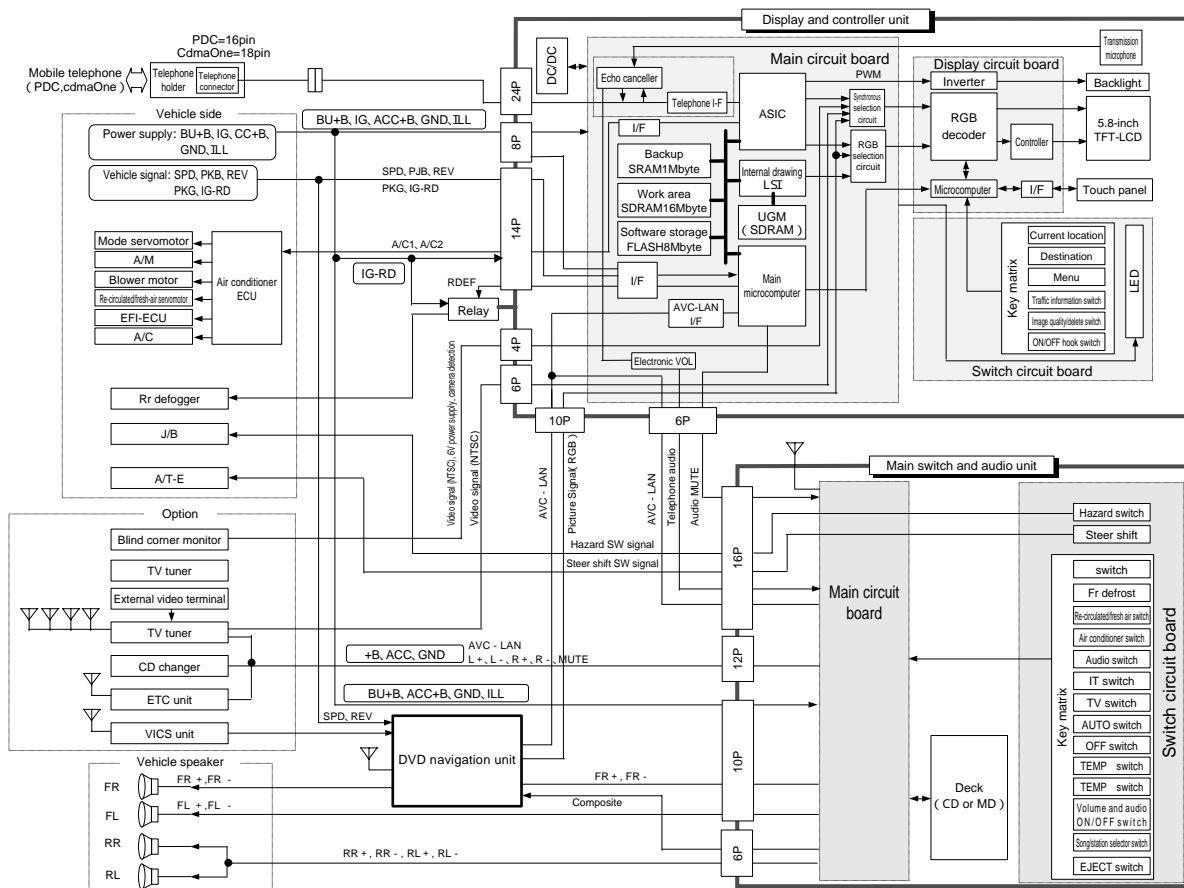


Fig.4 System configuration

6.3 Mobile telephone interface

As mentioned earlier, the hardware and software are guaranteed to be compatible with 32 mobile telephone models. But since each mobile telephone has its own features, several countermeasures were implemented for the circuits, ASICs, and software.

6.3.1 Voltage level of mobile telephone

While it is compatible with 16-pin and 18-pin mobile telephones, there are various mobile telephone terminal levels. It was possible that the IT cluster would be affected. Thus, the voltage level of all of the terminals of the compatible models was checked and countermeasures were implemented via the circuits through treatment of the terminals and/or a change of constants to prevent operation failure caused by wraparound of current, etc.

Table 4 Example of voltage level when mobile telephone terminal is opened.(PDC)

IT cluster terminal name	Mobile A (normal)	Mobile B
2	T-A	0.00
4	CNT1	2.80
5	UPDT	2.79
8	TCHC	0.00
11	TCHF	0.00
14	R-A	0.00
20	UNIT/CD	2.81
16	CNT2	0.00
17	DNDT	0.00
22	UNB/CD	0.00

Unit [V]

6.3.2 HDLC algorithm

HDLC is used as the method for communicating with a mobile telephone. With some of the latest models, however, data that is unneeded for the communication algorithm is sometimes sent. Because this could not be corrected through application of past intellectual property, the method used to process data in the ASIC was

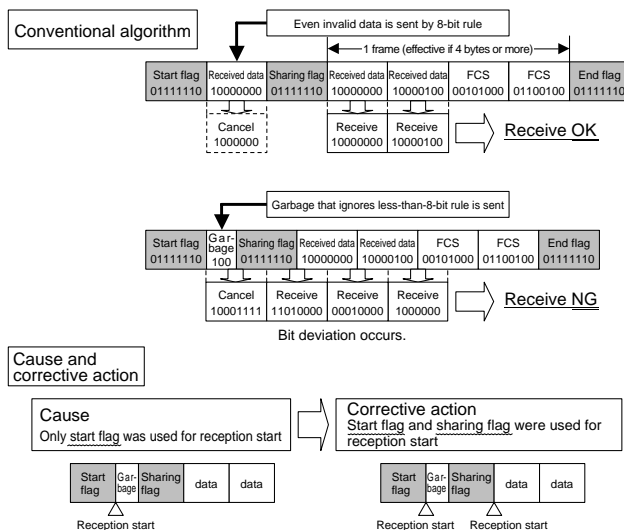


Fig.5 HDLC algorithm problems and solutions

improved. As a result, the probability of connection, which was only about 25% in some models, was improved to 100%.

6.3.3 Address book download

With the IT cluster, up to 1000 telephone numbers can be downloaded from a mobile telephone's address book. To minimize the time required for such downloading, software processing is employed to first retrieve information for the number of data items that can be stored in memory in the mobile telephone itself; then only that number of items is downloaded. In some models, however, information that exceeds the number of items in one's possession may be mistakenly sent. In such cases it may be impossible for the IT cluster to download the required data. Thus, for cases such as this, the problem was solved through an improvement that downloads the maximum number of items of information that can be downloaded to the IT cluster.

6.4 Screen size

As mentioned earlier, a 5.8-inch TFT liquid crystal display has been adopted for this product. Its size is typical of an in-car display, but is larger than the 2-inch display of a mobile telephone and handles more information. Thus, when displaying i-mode, it is extremely easy to view.

Table 5 Comparison of mobile telephones and associated screens

Item	IT cluster	Mobile telephone	Comparison
Area	5.8-inch wide	Approx. 2-inch	10 ~ 11 times greater
Number of pixels	H400xV234	Approx. H120xV160	4 ~ 5 times greater

6.5 Display system

It utilizes sequential sampling and does not blur, even when displaying detailed images and characters. (See Fujitsu Ten Technical Report 2001-38, Vol. 19, No. 2, p. 15.) For this reason it can clearly display i-mode and Internet characters and images, as well as navigation maps. Display signals (display clock, horizontal synchronizing signals, and vertical synchronizing signals) are sent to the drawing IC from the timing controller to generate drawing data. Thus, in the weak electric field of a TV, the on-screen display, such as the channel display, does not become distorted and the touch panel buttons can be pressed reliably even when there is a weak electric field.

6.6 Circuit board configuration

The circuit board has a four-board configuration (main board, display board, connector board, and switch board). A DC/DC converter module is mounted separately. The main circuit board consists of components such as the main microcomputer, which has overall control; internal-image drawing circuit; newly developed ASIC (for mobile telephone and air conditioner inter-

face); hands-free echo canceller, which does not generate an echo; microphone; and memory. The display circuit board is equipped with a special microcomputer for touch panel control, RGB decoder control, and timing controller control. The RGB decoder can basically make automatic adjustments and convert image signals to signals for the TFT liquid crystal display. An inverter circuit for backlighting is also installed.

Table 6 Primary circuit parts

TFT liquid crystal		TFD58W50
Touch panel		(Pressure-sensitive)
Main circuit board	Main microcomputer	SH3 (37MHz)
	Drawing LSI	Q2SD
	ASIC	MB87L4462PFV-G-BND
	Software storage	FLASH(8Mbyte)
	Work area	SDRAM(16Mbyte)
	Backup	SRAM(1Mbyte)
	Graphic memory	SDRAM(8Mbyte)
Display circuit board	Controller	TC200G11AF
	RGB decoder	RP5P006AM
	Panel microcomputer	μPD780054GC

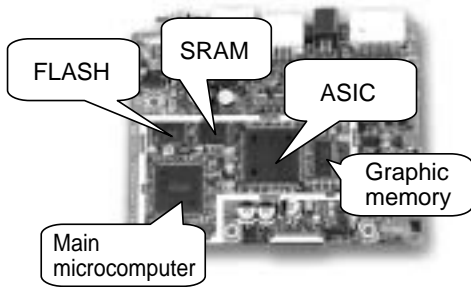


Fig.6 Main circuit board (front)

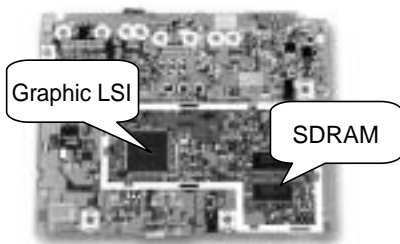


Fig.7 Main circuit board (back)

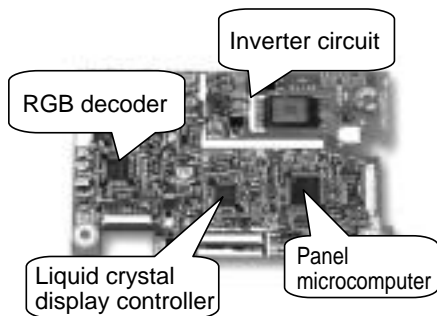


Fig.8 Display board (single-sided mounting)

7 Structural features

7.1 Flush structure

A surface formed by cutting off a portion of the vehicle cluster surface (curved) is used as the audio's decorative panel. A flush structure has been adopted with this IT cluster. The difference in grade between the cluster and audio surfaces is 0.5 mm, and the outside-perimeter clearance is 0.3 mm.



(MOVE : Display)

Fig.9 Flush surface structure

7.2 Gauges

As mentioned earlier, the IT cluster has a flush structure (decorative), so even though it is an electronic component, it is regarded as an interior decor part. In order to ensure precision between the mating surfaces of an interior decor part and another part, it is necessary to use 3D data to create a gauge of the shape of the other part, and to verify (examine) whether your company's parts are within the control tolerances for the data. A gauge such as that shown in Figure 10 was set up. This is the first time that Fujitsu Ten has tried using this gauge.



(MOVE : Display)

Fig.10 Mechanism gauge

7.3 Other

This model is used exclusively with subcompact vehicles. Since the distance from a user to the microphone is short, a hands-free microphone is built into the display. This has greatly contributed to cost reduction and simplification of the vehicle wiring, which in previous models was drawn to the base of the steering wheel

or sun visor. Furthermore, the number of hardware switches has been greatly reduced, a tree structure has been created with touch switches, and the switch character font has been enlarged as much as possible, providing a universal design that is easy to view and easy to press. In addition, a relay for switching the rear defroster has been installed on the back of the display.

8 Software development

The most significant feature is that two kinds of browsers, for i-mode and the Internet, are installed. Connecting a mobile telephone makes it possible to obtain various types of information (such as information on traffic, news, shopping, and sightseeing) while in the vehicle through i-mode and the Internet. And with a mailer installed, you can send and receive i-mode mail and e-mail. The "i-NaviLink" a function that links i-mode and the car navigation system, can also be utilized.

Furthermore, as mentioned previously, in order to take functions that are used with personal computers and mobile telephones and install them in vehicles as standard equipment, development proceeded with emphasis being placed on securing quality suitable for in-car equipment and on creating IT functions that are easily understood by users who do not normally use a personal computer.

8.1 IT unit control (control function)

The IT cluster's communication function makes use of a software modem that reapplies software modem technology (cdmaOne line switching system, PDC line switching system) that was established with a recently developed product. Also added to the modem is an i-mode communication function that is based on a PDC packet system for supporting DoPa.

Table 7 Transmission speed

Classification	Communication method	Model	Line
i - mode	Packet	503 series or prior	9600
		504 series	28800
Internet	Line	PDC	9600
		CDMA	14400

Unit[bps]

In models previously developed by Fujitsu Ten, single-function applications such as hands-free functions, server communication functions, and mail functions were operated exclusively. With the IT cluster, however, multiple applications such as i-mode mail, e-mail reception, and HelpNet can operate at the same time. In this connection a modem control task was newly developed, performing mode control between each module (application) and the software modem, as well as prioritizing calls and executing exclusive control. The modem

control task determines the priority when each function's application-level task requests that a call be sent/received, and ensures that the call having the highest priority is processed.

Table 8 Priority during transmission/receipt of transmission

Event \ Status	Telephone book retrieval	HELPNET emergency report	Manual HELPNET maintenance/inspection	Automatic HELPNET maintenance/inspection	i-mode PUSH message receipt	Other than i-mode PUSH message receipt	Internet	Manual e-mail	Automatic e-mail	Hands-free message receipt	Hands-free message transmission
Telephone book	/	/	/	/	/	/	/	/	/	/	/
HELPNET emergency report	/	/	/	/	/	/	/	/	/	/	/
Manual HELPNET maintenance/inspection	/	/	/	/	/	/	/	/	/	/	/
Automatic HELPNET maintenance/inspection	/	/	/	/	/	/	/	/	/	/	/
i-mode PUSH message receipt	/	/	/	/	/	/	/	/	/	/	/
Other than i-mode PUSH message receipt	/	/	/	/	/	/	/	/	/	/	/
Internet	/	/	/	/	/	/	/	/	/	/	/
Manual e-mail	/	/	/	/	/	/	/	/	/	/	/
Automatic e-mail	/	/	/	/	/	/	/	/	/	/	/
Hands-free message receipt	/	/	/	/	/	/	/	/	/	/	/
Hands-free message transmission	/	/	/	/	/	/	/	/	/	/	/

: Status maintenance(Error returned for event.)

: Event execution(Communication / call terminated for status.)

Also, the software function was divided into units (functional parts) and given a unitized design, whereby the interfaces between the units were clarified and then assembled. This arrangement makes it possible to utilize the quality and functions established for each unit, as well as meet delivery deadlines and ensure overall quality.

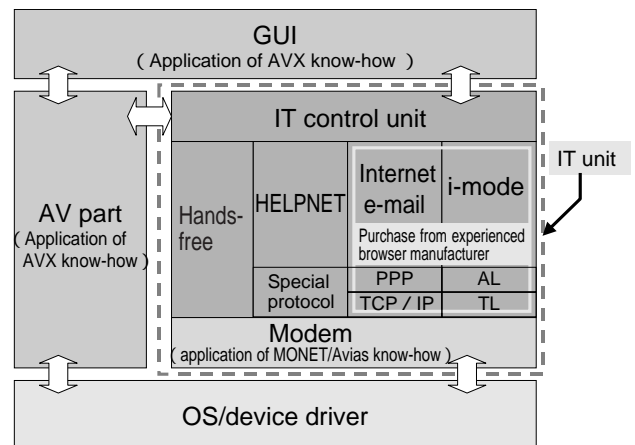


Fig.11 Software configuration

8.2 i-mode

If the user subscribes to NTT DoCoMo's i-mode service, the i-mode function can be operated by means of the IT cluster. Thanks to the touch panel and large 5.8-inch screen, the function can be used as one wishes, is easy to view, and provides an abundant amount of information, making it an extremely convenient tool. The i-NaviLink, the function that is linked to the navigation system, can also be operated. The i-mode browser that is installed for this product is based on Compact NetFront, which is manufactured by Access, and has the following functions:

- Compact HTML (HTML 4.0 subset)
- Navigation link function (positional information exchange)
- Mail/hands-free link function (address/phone number exchange)

8.2.1 Installation of switches for main menu

Since the i-mode main menu is used frequently, switches were added to the screen, making it easy to view and easy to make selections from the touch panel.

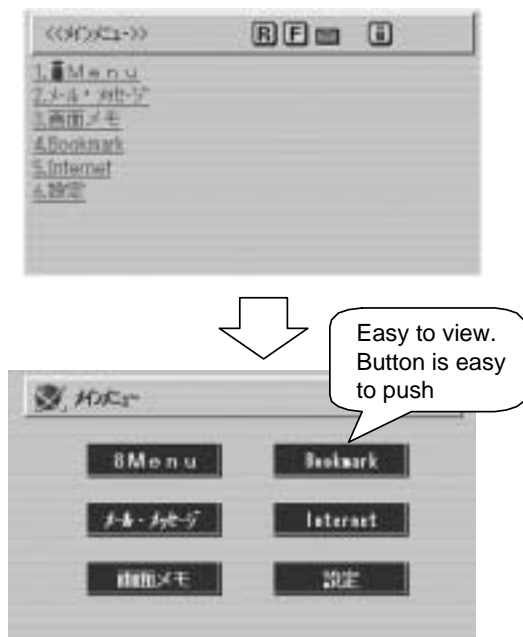


Fig.12 Installation of switches for main menu

8.2.2 Highlighting during anchor selection

During anchor selection (when an on-screen link display has been selected), the character background color is highlighted, improving visibility.

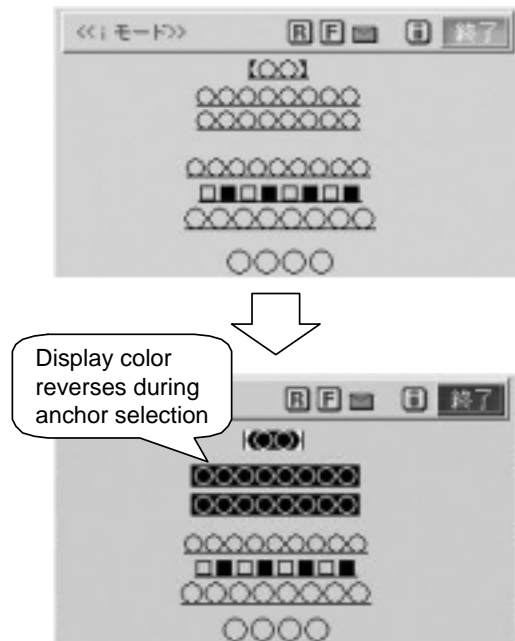


Fig.13 Highlighting during anchor selection

8.2.3 Change of mobile telephone screen display

Because an approximately 2-inch display is used with mobile telephones, the information that can be seen on a single screen is limited. This is particularly evident when one wishes to view news or other text that employs long sentences containing many lines. In such cases, it is necessary to scroll in order to read the entire document. Since the IT cluster, however, utilizes a 5.8-inch monitor, it can display a large amount of information on a single screen. This reduces the scrolling that is required for news and other long text, thereby improving visibility and making reading easier.

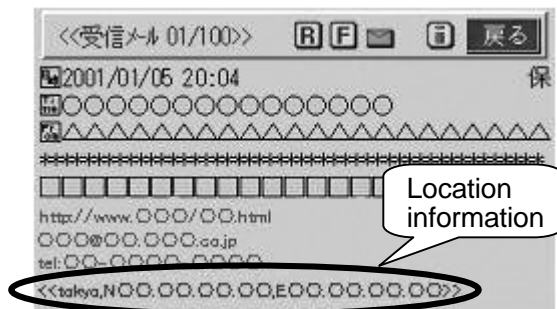


Fig.14 Change of mobile telephone screen display

8.2.4 i-NaviLink

The i-NaviLink is a convenient function that links a car navigation function to an i-mode function. It takes positional information that has been retrieved from a site that supports the i-NaviLink, and registers it at the car navigation destination or memory location. And if using mutual car navigation systems that support the i-NaviLink, positional information such as the current location and destination can be exchanged via i-mode mail. This is an extremely convenient way to set up meeting appointments. With the IT cluster, positional data and other information can be transmitted between the display unit and hideaway (separate-unit type) navigation system by using AVC-LAN. This gives practical effect to the "i-NaviLink" function.

Display positional information attached to mail, or i-mode site supported by i-NaviLink.



Touch positional information to display submenu. Select "Destination setup."



After destination appears on map on navigation screen, touch "Set" and set to destination.



Fig.15 Procedure for setting destination with i-NaviLink

8.2.5 Direct selection

When selecting from a menu or other list with a mobile telephone, it is necessary to move the cursor up/down and right/left with the cursor button and then press a confirmation button. Since the IT cluster uses a touch panel, operability is improved since a single touch is all that is needed to make a selection from a list.

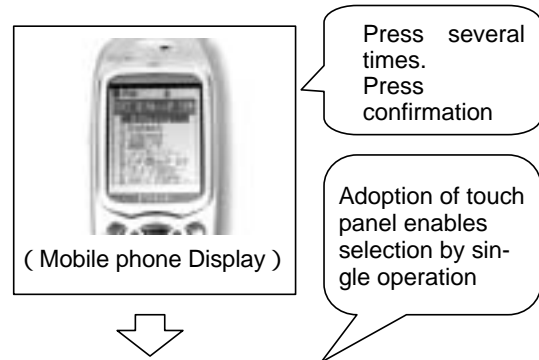


Fig.16 Direct selection

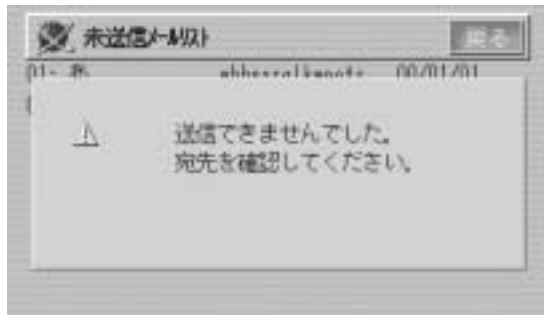
8.3 Internet browser/e-mail

In addition to the i-mode browser, an Internet browser that supports HTML 3.2 is also installed. The browser installed for this product is based on NetFront for Automotive, which is manufactured by Access, and has the following functions:

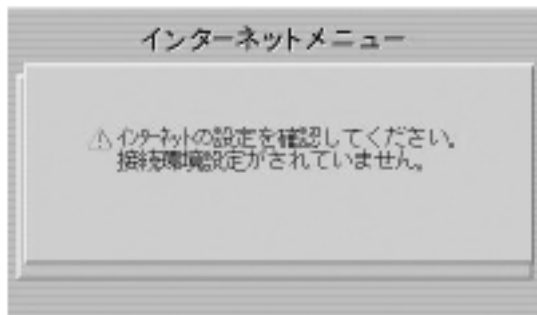
- HTML 3.2 + frame display
- Basic certification
- GIF/JPEG/X-BMP image display

8.3.1 Caution display

Normally, when the Internet and/or e-mail is used with a personal computer, a caution message is displayed only to notify the user that an error has occurred. Thus, if the user has no knowledge of personal computers and the Internet/e-mail, he/she will not know what action to take when the caution appears. For this reason the IT cluster displays the action that is required when a caution message appears. This enables users who have no experience with personal computers or the Internet/e-mail to operate the system.



Case in which mail could not be transmitted (example)



Case in which Internet connection failed (example)

Fig.17 Caution display

8.3.2 Character size and line spacing

The character size (large/small) and line spacing (wide/narrow) can be changed according to the user's preferences.

Table 9 Character size and line spacing

Setup	Ease of viewing	Amount of information	Figure
Characters: large; Line spacing: wide			
Characters: large; Line spacing: narrow			
Characters: small; Line spacing: wide			
Characters: small; Line spacing: narrow			



Fig.18 Character size and line spacing

8.3.3 Line connection status display

In order to use the Internet/e-mail, the user must have a mobile telephone. While the line is connected, call charges and connection charges are levied (by the provider with whom the contract is made). Thus, the system indicates the status of the line connection (line connection/disconnection time) by displaying indicators, icons, and cautions. This visually informs the user as to whether the line is connected and whether he/she is being charged. Moreover, when the line is disconnected, the connection time is displayed with the caution display.

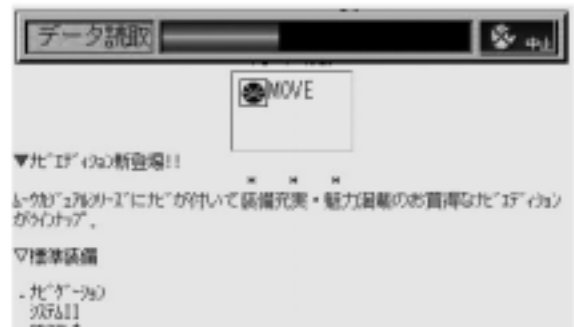


Fig.19 Indicator display during Internet connection (example)



Fig.20 Display during mail transmission (example)

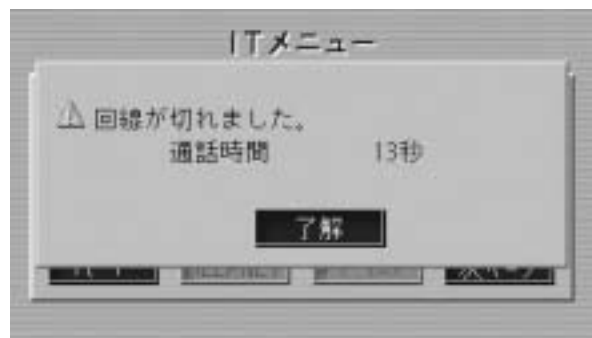


Fig.21 Call duration display when line is disconnected

8.4 HELPNET

HELPNET is a system that transmits information about the vehicle from the IT cluster to the HELPNET Center when trouble occurs as the vehicle is being driven. By being able to speak with an operator from the Center, the user can take prompt, appropriate action.

For example, if a person suddenly becomes ill, information such as travel data and vehicle location can be sent from the IT cluster to the HELPNET Center. Moments later the user can explain the situation to an operator from the Center via automatic, hands-free calling, and the Center can make immediate arrangements for an ambulance.

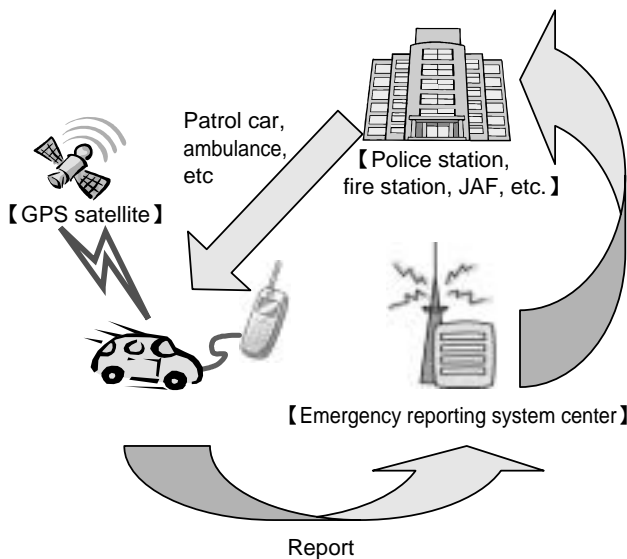


Fig.22 Summary of HELPNET

Equipment that is supported by HELPNET can be divided into three types, A, B, and C, from the aspect of reliability. The IT cluster belongs to type C.

Table 10 Classification of HELPNET functions

Type A	Type that confirms operation via vehicle installation status. Can automatically report via airbag activation signal interlock.
Type B	Type that confirms operation via single equipment unit. When accident occurs, can report by pressing report button installed inside vehicle.
Type C	Can use to report occurrence of sudden ailment other than vehicle accident.

8.5 Hands-free function

Hands-free calling using in-car speakers and microphone has been achieved. The front-right speaker is used for navigation audio output. For this reason, during hands-free operation, the output comes from the left speaker, preventing the navigation system audio from being interrupted. Thus, the user does not have to be concerned that the navigation audio will be cut off and

that the travel route will be incorrect.

8.6 Incorporation of quality into IT functions

To ensure in-car quality, the IT functions included in the two types of browsers are equipped with the vehicle manufacturer know-how described below.

To prevent data from becoming lost or corrupted due to a power supply interruption, data mirroring (which saves the same data separately from the reading/writing area) is executed. After confirmation that the data has been saved in the communication sequence, the Center-side data is deleted. To prevent cases in which the power will not turn off or the screen locks due to a loss of program control, which tends to occur with personal computer browsers, the browser's operation is periodically monitored and the browser is restarted if there is no response. To prevent the contents of memory from being destroyed, the utilized memory range is monitored and the browser is restarted if an abnormality is detected. And to prevent the line from remaining connected and charges to build without the user's knowledge, the line is forcibly disconnected when the display changes to a screen that does not require a line connection. Moreover, because of the destruction of NTFs (non-traceable failures) during the prototype stage, a flight recorder (function that records the status of communication with each unit of equipment) has been installed in the display software. Thus, even if failure conditions cannot be reproduced, the communication log can be analyzed, making it easier to analyze the status of abnormalities that occur.

Table 11 Incorporation of quality into IT functions

Item	Problems	Measures
Data guarantee	Data loss and data corruption occurs due to ACC power supply interruption. [Example] Mail that has been received disappears before being read.	1)Mirroring of backup data 2)Through the communication sequence with the Center, the Center-side data is deleted after confirmation that the data has been saved on the IT cluster side.
Operation guarantee	Program goes out of control; consequently: Screen locks. Power will not turn off. Contents of memory are destroyed.	Screen locks. Power will not turn off.The browser's operation is monitored through periodic communication, and the browser is restarted if there is no response. Contents of memory are destroyed.The utilized memory range is monitored and the browser is restarted if an abnormality is detected.
Billing guarantee	The line remains connected and charges continue to accrue without the user's knowledge.	The line is properly disconnected by screen mode change from the Internet screen.
Elimination of NTF	During the prototype stage, a non-traceable failure occurs, preventing analysis.	The system is equipped with a flight recorder that records and analyzes the status of abnormalities that occur.

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Future challenges

Challenges for the future include finding ways to increase the amount of information that can be displayed on a single screen and to increase the transmission speed. For the former challenge, converting from the current EGA (H400 × V234 dots) to W-VGA (H800 × V480 dots) will make it possible to display at least four times as much data, enabling the user to view almost any standard Internet site stress-free. W-VGA is already becoming a standard item in luxury vehicles and sooner or later will likely be installed as a standard item in subcompact cars as well. The latter challenge depends to a degree on the generational change in mobile telephones. But for CDMA packet support, it is possible to provide only with software support. The IT cluster, too, can achieve approximately 100 Kbps (effective).

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Conclusion

With this development our company was able to complete its first "car infotainment" product. We were also able to take the industry lead in developing the standard in-car display market for subcompact vehicles. With the development of browsers and evaluation methods for mobile telephones, we were also able to build a foundation for the design and evaluation of 2003 and 2005-model car infotainment products. Thanks to the enjoyment of using the i-NaviLink and i-mode on a large in-car screen, as well as the ease with which a browser link can be directly specified via the touch panel, we expect the system to come into widespread use.

References

Motoshi Watanabe et al: "Development of an AVX Unit That is Compatible Throughout the World," Fujitsu Ten Technical Report 38, Vol. 19, No. 2

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