# Platform Concept for Global Expansion

## First article: Development of AVN for 2010 Autumn Model for Japanese Market


*Takashi EGUCHI*
*Junji ONISHI*
*Fumitake NAKAMURA*
*Kazunari MIZOWAKI*
*Toshihito SAWAI*




## Abstract

In Japanese car navigation system market, the sales of low-priced AVN have been growing and they are expected to continue to grow in the future. On the other hand, in overseas car navigation system market, the demands for AVN to be installed neatly and smartly have been increased.

Hence, Fujitsu Ten has brushed up the technology cultivated in "AVN Lite" that we launched in autumn 2008, has improved a cost-competitiveness to beat our competitors, and has promoted planning/development of models for global expansion that realizes an area optimization.

In this article, we introduce a product outline (the first article: 2010 autumn model for Japanese market), requirements and concrete realized measures on the platform for the global expansion.

## 1 Introduction

In the current Japanese market, the sales of car navigation system have been increasing. Its prices are lowering with the spread of PND (Personal Navigation Device), and the car navigation system is being clearly polarized between the PND and AVN (installed-type all-in-one navigation). Also in the AVN, the demand has been shifted to a low-priced model of 100,000 yen or less (**Fig. 1**).

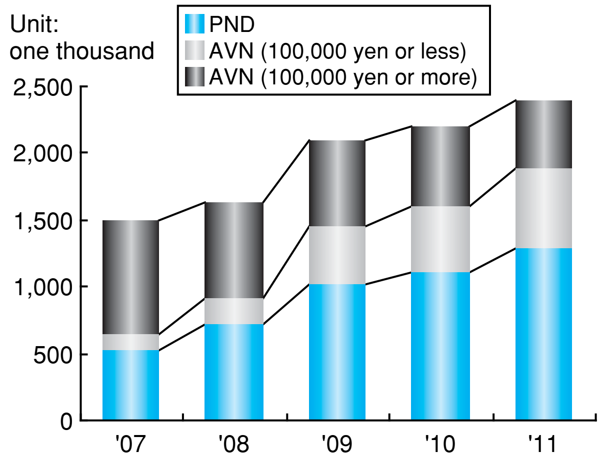


Fig.1 Transition in Japanese Car Navigation Market (Sales Volume)

In the market outside Japan, the PND has led the car navigation system market and its sales have been significantly increasing. Under this influence, the sales of the AVN also have been steadily increasing and a certain size of the AVN market has been established. The AVN has a great future potential (**Fig. 2**).

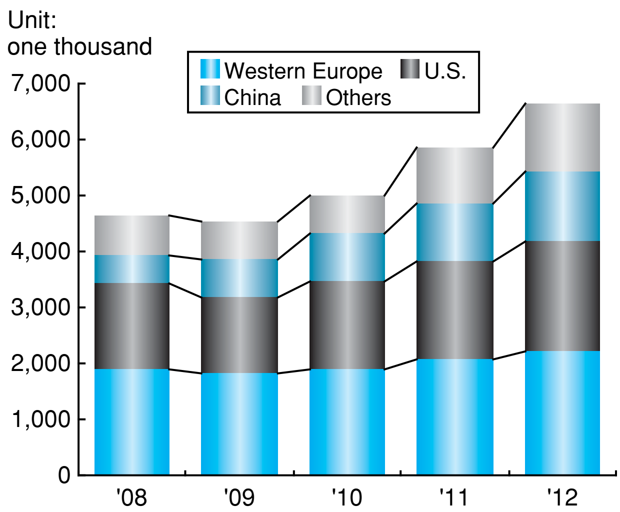


Fig.2 Transition in Overseas AVN Market (Sales Volume)

Because of the above-mentioned situation, we can see the AVN is in high demand worldwide. However, there is a major challenge of "price reduction" in both the PND and the AVN, and if focusing on more rapid product development, we need to develop a platform for global expansion.

The global platform has to meet both common needs around the world (e.g. high-definition display) and the needs depending on the countries and customers (e.g. terrestrial digital television in Japan, digital radio in U.S, RDS in Europe).

In other words, the requirements for the global platform are as follows:

**[From a viewpoint of customers]**

- **High-quality sound and high-quality image that are the basic requirements**
- **Detailed tone control according to the favorite tone and the environment in a cabin**
- **Supporting PC audio contents (MP3/WMA)**
- **Responding to radio broadcasting system of each country**
- **Enjoyable and understandable HMI (animation display, etc.)**

**[From a viewpoint of design/how to make]**

- **System capable of changing functions easily according to required specification**
- **Easy-to-make mechanical structure**
- **Software capable of developing applications worldwide**

We'll describe the concrete realized measures for the system/electrical/mechanical/software structure to meet the above-mentioned requirements in chapter 2. First, we introduce the functions and features of our first applicable product, AVN 110M, for 2010 autumn model for Japanese market.

### 1.1 Introduction of AVN 110M

In autumn 2008, we released AVN Lite targeted at "customers who do not use a car navigation system" with a keyword of "Safe, easy, and fun." This product became a huge hit, exceeding twice our sales target, and it became an innovative product sold at the rate of one-tenth of the commercially-available AVN released after autumn 2008.

We released New AVN Lite in autumn 2010, taking over the concept of the AVN Lite and brushing up it.

**[Easier to see and use]**

- **Wide QVGA display and LED backlight**
- **GUI (Fig. 3) pursuing an ease of use**

**[More secure navigation]**

- **Easily setting up to five destinations responding to the multiple destinations**
- **Always receiving FM-VICS with FM-VICS tuner**


(Hugely popular double-screened display including navigation screen and AV screen)


(Widely displaying often-used items)

Fig.3 Display Screen

**[More fun AV functions]**

- **Easily customizing tone by upgrading the tone control function**
- **Improving response capability to media by installing a music playback function with USB memory**

Furthermore, we also developed a model for corporate customers.

The model responses to the individual specification change (restriction function of watching 1seg) and to the foreign language (English) required rapidly for a rental car.

## 2 Outline of System Configuration

To develop the products for the global expansion, we need to respond to the functions in accordance with the needs of each country and customer, and furthermore, need low-cost system structure.

Even low-cost model, the factors such as high-quality image and high-quality sound are the major purchase motive for users, and therefore, we need to provide a product with a superior cost performance.

In this chapter, we introduce the following four points related to the system configuration and hardware design of the AVN 110M:

- **System configuration**
- **Video structure**
- **Radio/audio structure**
- **Front-loading for noise suppression**

### 2.1 System Configuration

In the previous products, we had achieved a high functionality by installing multiple CPUs for each function and distributing CPU load. However, it was apparent that the system following the previous product concept cannot reduce the cost while maintaining and improving the basic performance, in parallel with meeting the various required specifications from respective regions.

Hence, we reviewed the system configuration implementing the distributed processing in the multiple LSIs and CPUs, and changed to the system including one CPU-based three components (**Fig. 4**).

①A core area: an area in which an I/O interface is included to respond to functions required from a global viewpoint with a main CPU at the core and modifications will not be made

②A common area: an area in which devices (GPS, deck, etc.) required to implement functions not changed for each region and customer are installed

③A specific area: an area in which devices (in-vehicle LAN, TV reception, etc.) required to implement functions unique to regions and customers are installed

The above-mentioned system allows us to focus on the development of functions in the specific area ③ if we develop a derivative model, and therefore, we can shorten the development period.

We determined the CPU requirements based on the required functions and newly adopted devices meeting the specifications of the products. However, an interface (IO) with peripheral devices is insufficient with a single CPU alone, and therefore, we developed IO-ASIC for the extension.

In IO-ASIC, we extended the insufficient analog port and serial port, and incorporated the touch panel/key scan control previously implemented by the software processing and individual function differing from country to country to reduce the CPU load.

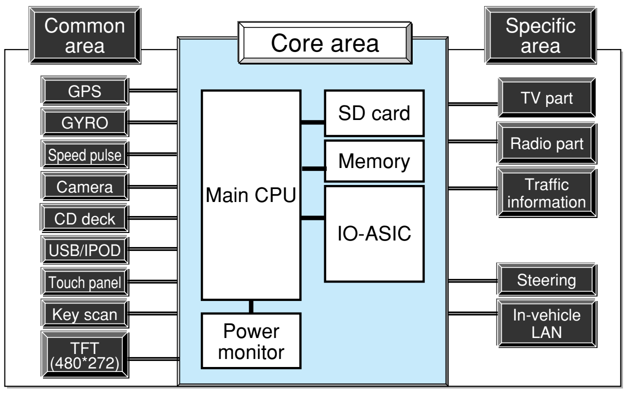


Fig.4 System Configuration Diagram

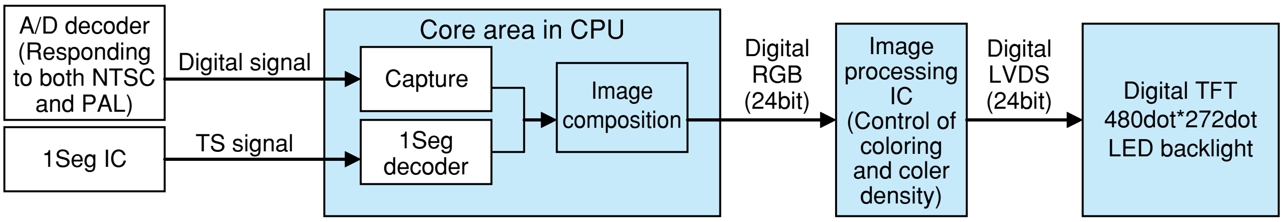


Fig.5 Block Configuration of Video

## 2.2 Video Structure

This platform has the configuration (**Fig. 5**) that responds to the following two points for the better image quality (improvement of vividness and sharpness) than the previous model.

**[Full-color digital transmission]**

For full color (24-bit processing) of the video processing, we increased the number of colors to be displayed by 61 times, compared to the conventional model and improved the vividness (**Fig. 6**).

**[Digital TFT]**

By newly adopting the digital TFT, we eliminated errors caused at the time of AD conversion and created the clear display without color blurs (**Fig. 7**).

Furthermore, by using LED in the backlight, we not only improved the vividness, but also achieved a mercury-free and considerable energy savings, leading to an environmental effort.

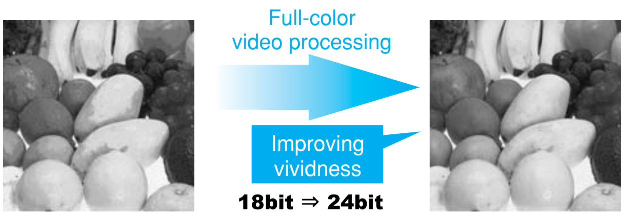


Fig.6 Full-color Video Processing (Image)

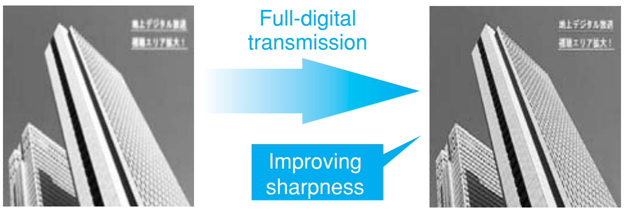


Fig.7 Full-digital Transmission (Image)

## 2.3 Radio/Audio Structure

The radio system varies depending on the countries. Given the global expansion, it is extremely difficult to standardize the radio system, and it is imperative to respond to HD-Radio, DAB, and RDS/RDS-TMC in Europe and the United States.

In this platform, we determined the block configuration of radio/audio, aiming the global expansion and improvement of the sound quality (**Fig. 8**).

**[Response to global radio system]**

We adopted a digital tuner capable of responding to the differences of specifications for each country by changing the software. Also we made study on the response to the digital radio broadcasting and traffic information service outside Japan by adding the extension device.

**[Full digitalization of audio]**

We adopted the device integrating the DSP and baseband processing of the radio, and connected the radio, CD, USB and iPod with the DSP through the full digitalization. Furthermore, we improved the sound quality by implementing the tone control processing and converting into an analog signal with 24 bitDAC in the DSP.

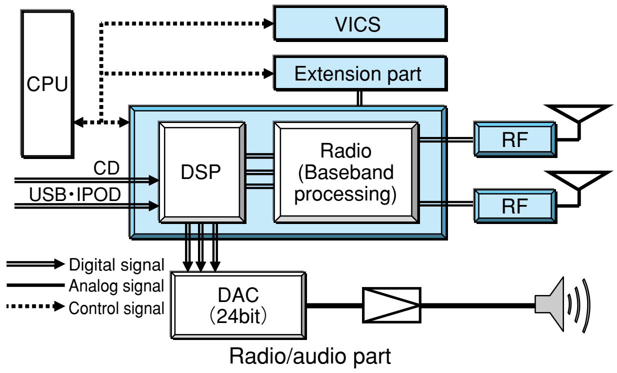


Fig.8 Block Configuration of Radio/Audio

## 2.4 Front-loading for Noise Suppression

In this development, we significantly modified the platform, and a key point was to analyze the noise of the product in a short period of time.

We carried out a simulation analysis based on CAD printed board data and optimization simulation verification based on an actual equipment.

**[Printed board design stage: power source impedance analysis]**

Lowering the power-line impedance is an effective measure to reduce the noise, and therefore, we focused on it this time.

Based on the CAD data, we carried out the power-line impedance simulation analysis to optimize a placement of a bypass capacitor.

In 1.5GHz frequency band of initial data, the signal impedance had been around 100Ω, but we obtained the stable impedance of around 10Ω after taking measures

(**Fig. 9**).

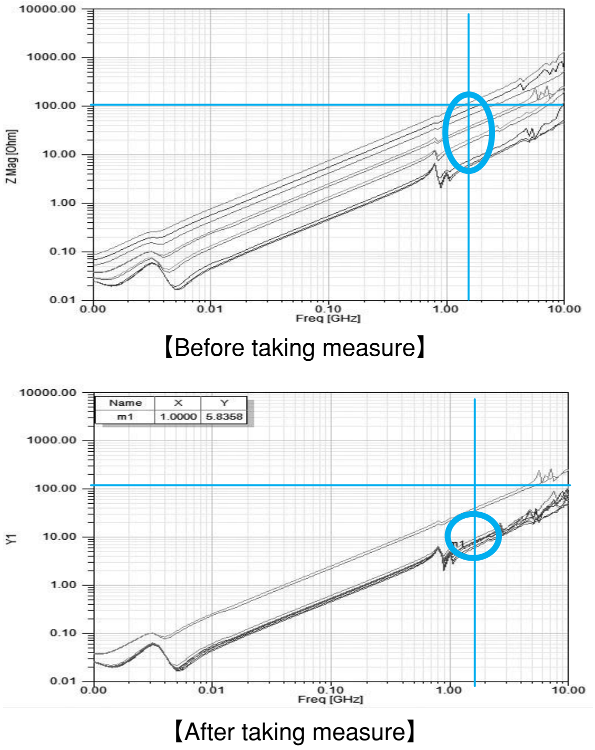


Fig.9 Power Source Impedance

**[Prototype stage: transmission line analysis and power source GND resonance analysis]**

In the first stage prototype, we carried out the transmission characteristic analysis and power source GND resonance analysis with a single printed board alone. We reflected the noise source pattern shielding, optimal VIA placement, crosstalk improvement pattern between signals into the second stage prototype (**Fig. 10**).

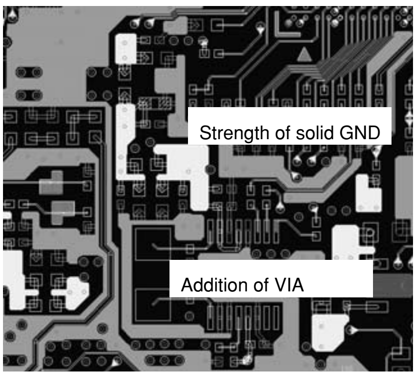


Fig.10 Example of Pattern Reflection

As a result, we reduced the radiation noise in UHF band by 5 to 10 dB totally and achieved the noise criteria in the second stage prototype, leading to the reduction of man-hours of reviewing by about 30 % (**Fig. 11**).

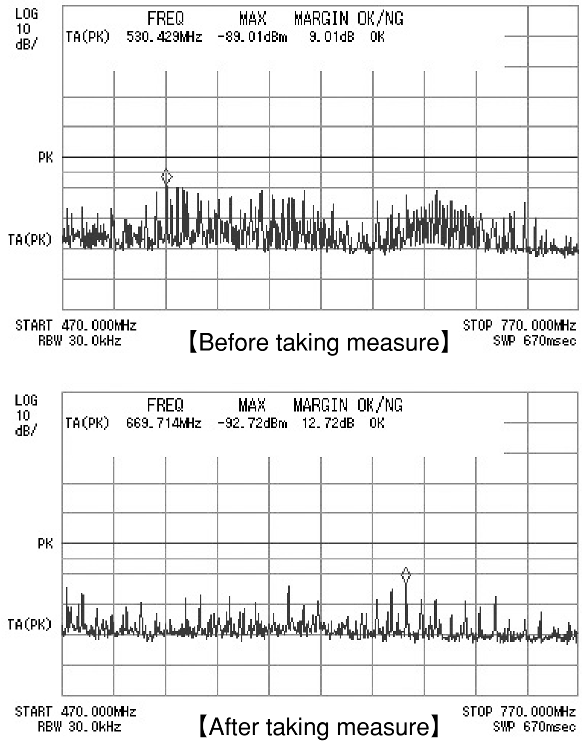


Fig.11 Product Radiation Noise (UHF)

## 3 Outline of Structural Design

In this chapter, we introduce our approaches to the platform structure of inside equipment.

**[Review of conventional concept]**

We had adopted a building-up structure for the platform concept of inside equipment for the developed model of up to fiscal year 2009 (**Fig. 12**).

The building-up structure refers to the structure in which the parts are built up on the base chassis of TILT mechanism by placing the holders and printed boards alternately. Then the deck is placed on the top of the structure, and lastly, the structure is covered with the chassis to complete the product.

The advantage of the building-up structure is the high productivity in the case of introduction of the Japanese robotic cell production system because of the suitability for the line automation without the need to rotate the product.

On the other hand, the disadvantage of the building-up structure is the increase of the man-hour for assembly and processing cost for the manual production due to the increase of the parts (increase of the number of the screws) caused by the necessity of the same number of the holders as that of the printed boards to hold the printed board because of the composition of the internal parts by the building-up method.

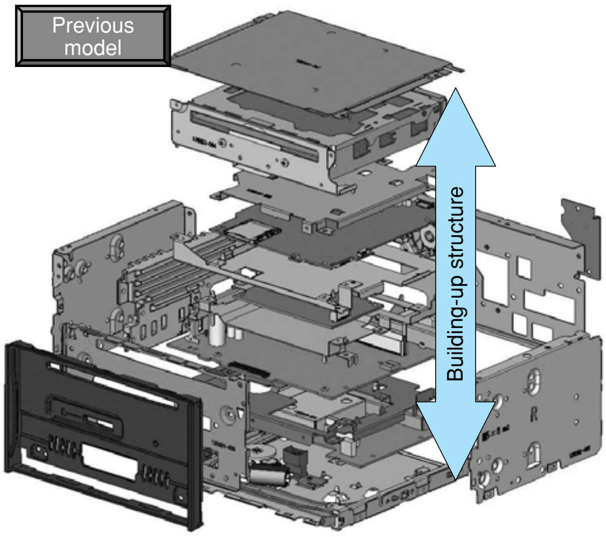


Fig.12 Exploded Diagram of Current AVN Lite

**[New platform for global expansion]**

We regarded this 110M as a fundamental development and considered the platform concept of inside equipment, seeking "easy manufacturing" and "low cost" conforming to the production method (in the subsidiaries outside Japan). And then we set the following development targets to carry out the concept design:

- **Cost target: reduction by 30%**
- **Parts target: reduction by 30%**
- **Screws target: reduction by 30%**
- **Weight target: reduction by 20%**

We introduce the main approaches below.

## 3.1 Design for Space-saving

First, in the product planning department, the derivative models development plan over the next three years and their required functions were extracted, and in the electric department, the required area of the printed board was calculated based on the close investigation on the functions in accordance with the needs of each country. The basic structure of the printed board includes two printed boards composed of one audio printed board and one CPU printed board, and the CPU printed board is fixed on the face of one holder and the audio printed board is fixed on the reverse side of the holder to save the space (**Fig. 13**). As a result, as for the extended functions, we were able to get space for installation of the additional printed board. This allows us to respond to the additional functions without any modifications of the basic structure.

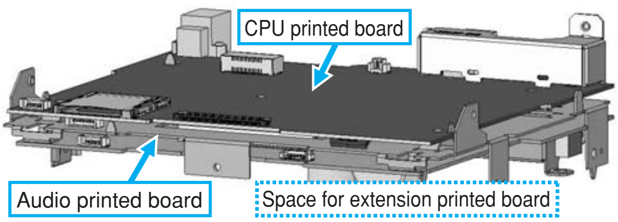


Fig.13 Printed Wiring Board ASSY

## 3.2 Approaches to Reduction of Screws and Front Panel

In this platform, we optimized the structure using a stress simulation at the conceptual stage to reduce the number of screws and weight while maintaining the same strength as that of the building-up structure.

As for the screws, we implemented optimum arrangement of the screws as follows: under the assumption of the application of the impact load equivalent to 60 G in CAE analysis, we ran a tensile/shear stress simulation for each screw (**Fig. 14**). Then we removed the unnecessary tightening and together tightened the areas that are able to share the tightening wherever possible.

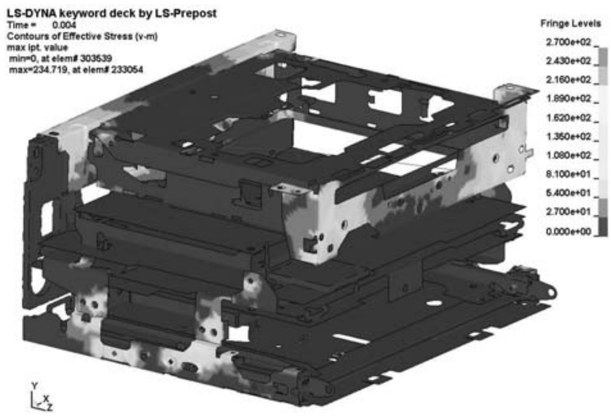


Fig.14 Impact Simulation

As for the chassis, under the assumption of the application of the impact load equivalent to 60 G, we selected proper board thickness and optimized the shape based on the stress distribution of the chassis surface. Also we concurrently ran a vibration resistance simulation because of concern about the influence on the deck vibration resistance due to the shape change (**Fig. 15**).

As a result, we were able to remove the front panel structurally.

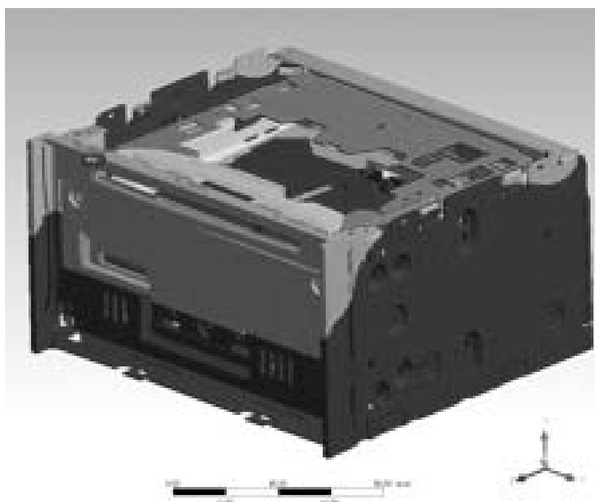

Fig.15 Deck Vibration Resistance Simulation

We concerned about the influence of ANT noise radiation to the vehicle due to the removal of the front panel. Therefore, we ran the product noise simulation as well as the above-mentioned printed board noise simulation to incorporate the quality at the stage prior to prototype production (**Fig. 16**).

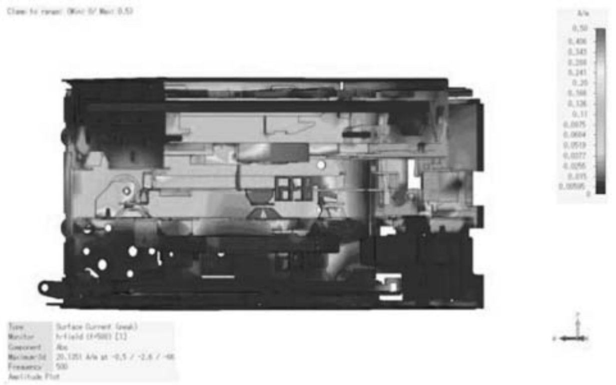

Fig.16 Product Noise Simulation

Also we ran a temperature simulation. In this way, running of the simulation concurrently allowed us to carry out the short-term development and quality front-loading.

Through our main approaches described above, we reduced the cost by minimizing the functions of component parts and reviewing the platform concept. Also we reduced the man-hour for development design of derivative models by restricting the changes for the additional functions. **Fig. 17** shows the structure of inside equipment of AVN 110M.

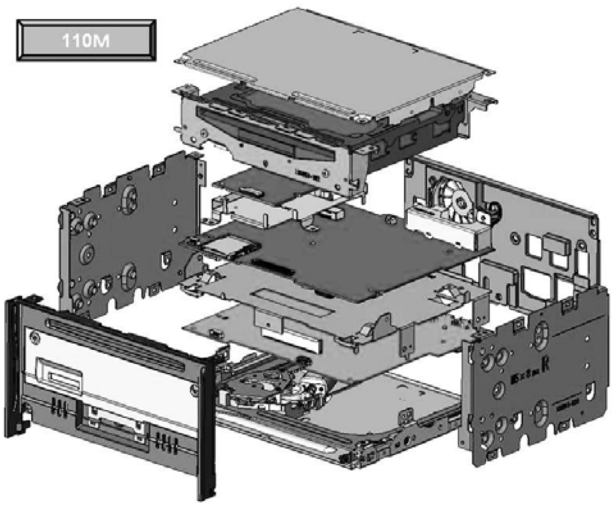


Fig.17 Inside Structure of AVN 110M

**Table 1** shows the results compared to the targets set at the beginning of development.

Table 1 Comparison between AVN Lite and AVN 110M

| | Target | AVN Lite | 110M | Result |
|---|---|---|---|---|
| Number of parts | Reduced by 30% | 24 | 15 | Reduced by 37.5% |
| Number of screws | Reduced by 30% | 71 | 39 | Reduced by 40.5% |
| Weight of internal equipment | Reduced by 20% | 2912g | 2290g | Reduced by 21.3% |

## 4 Software Configuration

For global expansion, we have to consider the expansion of the AVN to every region in the world. In other words, we need to respond to the diversification of specifications for each country and region. To respond to the enormous number of models, we needed to establish the structure easily capable of replacing each function not only in AVN Lite series but also in other models, and to minimize the man-hour. **Fig. 18** shows the software configuration.

In this chapter, we explain three changed points of the software configuration to respond to a wide variety of models and specifications (box with red border in **Fig. 18**).

### 4.1 Common I/F

First, we established "common I/F (Inter Face)" operating resources of OS (Operating System) used by each application. This reduces the dependence on the OS by each application and easily transports the application operating on other OS.

Next, we established "model dependence layer" absorbing the difference of the OS for I/F standardization.

In this way, we aimed to establish the structure for standardization of software including other models.

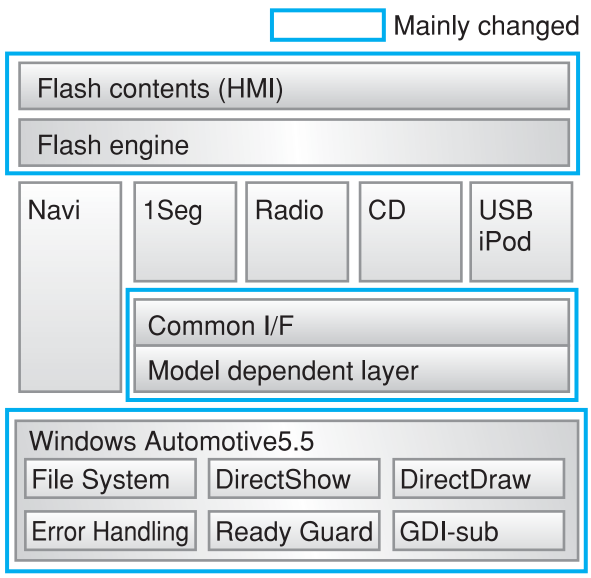


Fig.18 Software Configuration and Main Changed Points

## 4.2 Adoption of Flash Engine

### 4.2.1 Response to Animation

Previously we had established HMI (Human Machine Interface) by Fujitsu Ten's own drawing frame work (hereinafter, referred to as F/W). However, the drawing F/W had reached the limit due to the multi specifications for the global expansion. Hence we installed an engine (NetFront FlexUI produced by ACCESS) for playback of Flash Lite contents to enrich the HMI such as the animation.

It was difficult to implement an animation in the previous model (AVN-Lite before 2009 model). However, the adoption of the Flash engine allowed us to easily implement the animation and ensure the smooth animation. **Fig. 19** shows the screen during switching between "multiple screens including a map display screen for navigation and a display screen for radio function" and "full-screen for radio function." In this way, imaging during the animation that we had not achieved previously became possible. We use the animation effect for a pop-up warning screen and a counter of playback time.

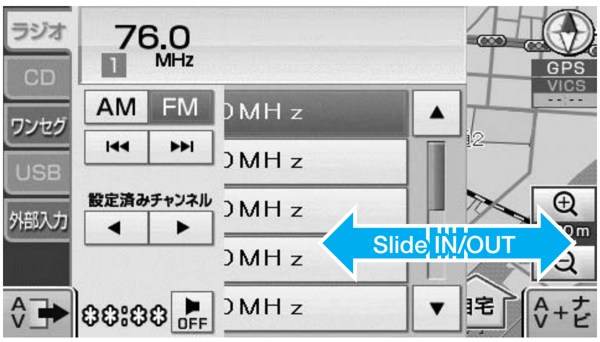


Fig.19 Example of Animation

### 4.2.2 Change of Development Process

The adoption of the Flash engine allowed us not only to ensure the animation but also to review the development process.

**Fig. 20** shows the development process before/after the review.

Currently, the screen specification and screen transition specification are created in the planning department and they are provided to the software development department. However, the specifications cannot include all concepts of the planning department and the specifications often have to be changed after the screen transition and screen design are incorporated. The adoption of the Flash will allow anyone to create the screen specification and screen transition specification on a PC using a tool, and therefore, the Flash file including the screen design and screen transition specification can be created at the planning department. In other words, the creation of a moving specification becomes possible. In the software development department, it will be possible to implement the functions of products by incorporating the motion during pushing a button, based on the Flash data. Also it will be possible to preliminary confirm the motion that we cannot confirm until the motion is incorporated into the product actually, and it is expected to reduce the man-hour of software development.

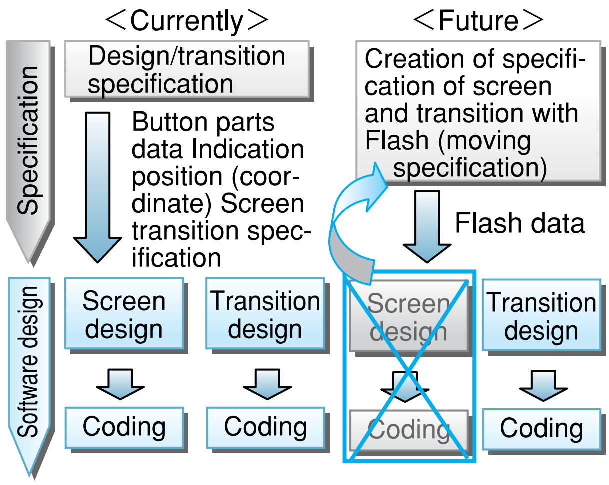


Fig.20 Change of Development Process

## 4.3 Adoption of Windows®

For the global expansion, we needed to transfer the platform of software from existing iTRON OS to universal OS. The iTRON is the most popular OS in Japan but not in other countries. For the global expansion, we needed to replace the iTRON OS with more popular OS. Especially, it was essential to shift to the platform capable of replacement because of the installation of the navigation application (hereinafter, referred to as navi-appli) in accordance with the needs of each country/region. Hence, we adopted "Windows® Automotive5.5 (hereinafter, referred to as WA5.5)," for vehicle installation, based on Windows® CE which is the most popular OS for PDA (Personal Digital Assistant).

Adopting the universal OS such as Windows® also has the following advantages:

- **It has various middleware as standard.**
  **(File System, decoder for MP3, communication function, etc.)**
- **There are many manufacturers to develop it.**

**These show that the universal OS such as Windows® has potential to install the functions meeting the customers' needs immediately.**

### 4.3.1 Issues on Transition to Windows

Windows® CE 5.0 for general incorporation had been thought to be not suitable for the vehicle installation because the Windows® CE 5.0 takes time to start up. However, this problem was resolved by adopting the WA5.5 in which the solutions for the high-speed start-up has been provided. However, we still had issues on the implementation so needed to take enough time to examine the issues in the early phase of development. One of the solutions for the high-speed start-up of WA is Ready Guard (hereinafter, referred to as RG). Here we explain the system of the RG (**Fig. 21**).

When the WA is started, the OS with the minimum configuration, called RG OS, is started at high speed firstly (**Fig. 21-a**). The minimum module that has to be started up can be started up. As a result of the various examination, we decided to start up the in-vehicle LAN communication function, communication function between microcomputers, power supply control function, etc.

Next, MAIN OS is started up in parallel with the RG OS. When the preparation for start-up of the MAIN OS is completed, the OS is switched from the RG OS to the MAIN OS (**Fig. 21-b**). In this case, the process operating on the RG OS continues in the MAIN OS, and the RG OS stops. In this way, the functions that have to start up at high speed are started up by the RG OS, and the process such as the navi-appli that may be started up later is started up by the MAIN OS to realize the high-speed start-up.

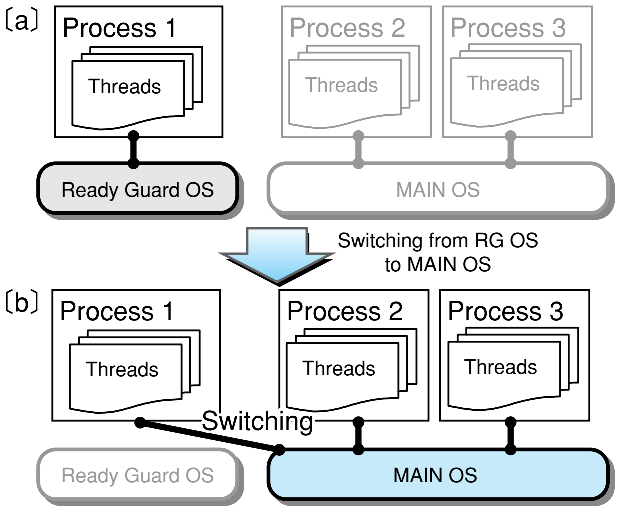


Fig.21 Structure of High-speed Start-up

## 5 Conclusion

As for the AVN by Ryohin-Renka (low-cost and non-defective product), we developed our own platform for the global expansion by sorting out the performance and functions based on the regional characteristics and customers requirements.

We hope to improve the convenience of our customers by advancing and developing the products that have linkage with the vehicle and various information centers, which only the single piece of in-vehicle equipment had not achieved.

Lastly, we express our sincere appreciation to manufacturers of software and device for their supports in the development of this platform.

## Profiles of Writers

**Takashi EGUCHI**

Entered the company in 2003. Since then, has engaged in the advanced development of AVN after the AVN system design. Currently in Engineering Planning Department, Advanced System Planning Division, Products Management Group.

**Junji ONISHI**

Entered the company in 2005. Since then, has engaged in the mechanical development of AVN. Currently in Mechanical Engineering Department, CI Engineering Group 1.

**Fumitake NAKAMURA**

Entered the company in 2003. Since then, has engaged in the product planning of navigation/audio system. Currently in Aftermarket Promotion Department, Product Management Division 1, Products Management Group.

**Kazunari MIZOWAKI**

Entered the company in 2001. Since 2006, has engaged in the software development of AV products after working in engineering development department. Currently in Software Engineering Department 1, CI Software Division, Software Engineering Group.

**Toshihito SAWAI**

Entered the company in 1981. Since then, has engaged in the development of AVN after the development of audio equipment. Currently the Department Manager of Engineering Planning Department, Advanced System Planning Division, Products Management Group.