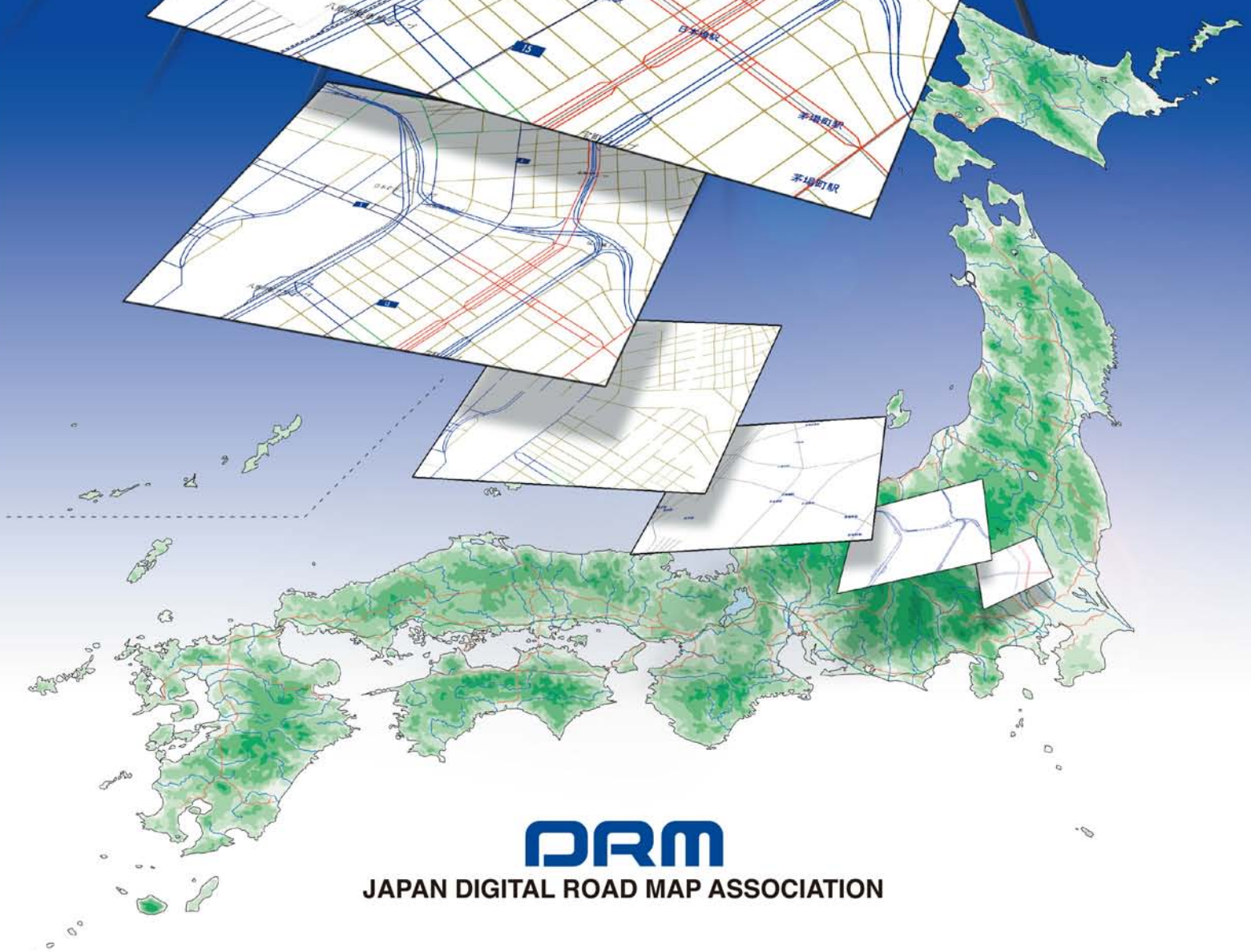
Digital Road Map

The Essential Basis of ITS
for
Safer, Smarter and Cleaner Road Transport



DRM

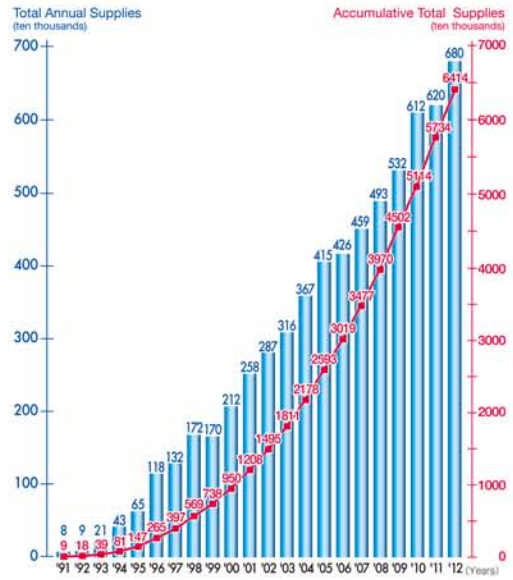
JAPAN DIGITAL ROAD MAP ASSOCIATION

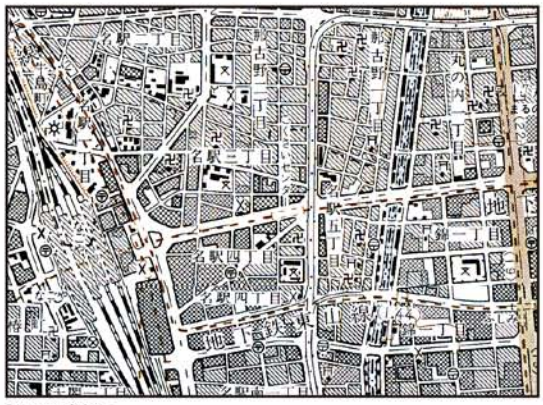
What Is the Digital Road Map

01 Outline of the Digital Road Map

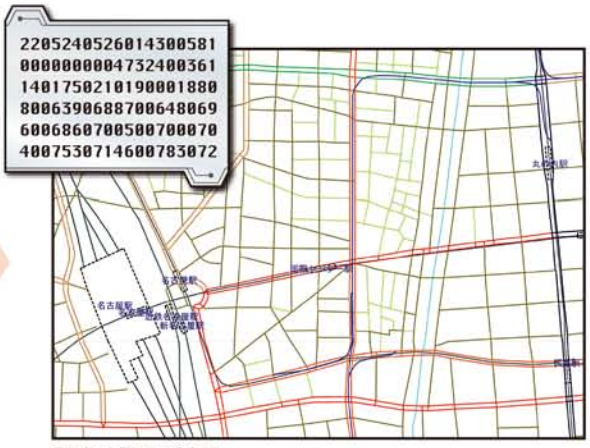
The Digital Road Map Database (DRM Database) is the standard national digital road map database supporting Japanese ITS infrastructures. This database consists of digital cartographic data in which locations and other information are expressed in numeric form, so that computers can recognize roads, intersections and so on. The DRM Database allows car navigation systems and the like to display road maps on their screens and search for the suitable route to a destination avoiding traffic congestion.
The Japan Digital Road Map Associaton (DRM Associaton) creates, updates and provides the DRM Database based on public-private collaboration.

Number of DRM Database Units Supplied Annually and Accumulatively

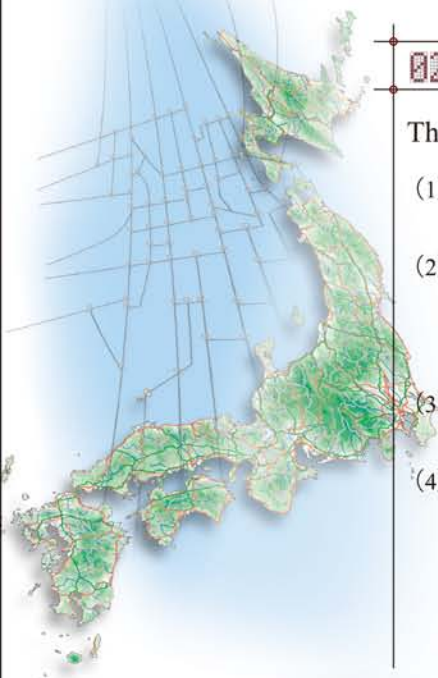




Paper Map
(This is a part of the 1:25,000 scale topographic map "Northern and Southern Nagoya" issued by the Geospatial Information Authority of Japan(GSI)



Digital Road Map
(The digital road is recorded as a set of numbers and letters. This is an example of a depicted image produced by software that can convert this alphanumeric data into visual form.)



02 Characteristics of the Digital Road Map

The characteristics of the digital road map, especially the DRM Database, are as follows:

(1) The data structure is suitable for depicting networks, and allows computerized searches for the route with the shortest distance, time, etc.

(2) Data on arterial roads of the prefectural level and higher is updated in advance of road openings and other changes. This data is highly precise, based on large-scale construction planning maps provided by road administrators. Other data is updated all at once when new topographic maps are issued.

(3) In addition to location information, the maps also include a great deal of other data such as each road administrator, route number, width, and road structures such as bridges and tunnels.

(4) In addition to establishing and publishing the database standards※ the DRM Associaton also assigns unique node and link IDs. These IDs are shared in the public and private sectors and used when exchanging information related to road transport, including construction, accidents, and congestion. The DRM database is an authoritative database serving as a common infrastructure for the exchange of various types of information among public and private sectors.

※ The current standards are the National Digital Road Map Database Standards. However, the DRM Standard Format 21 has also been in use since 2005.

How To Make the Digital Road Map

03 Database Creation and Update

Initially, the DRM Database was created based on the 1:25,000 topographic maps issued by the Geospatial Information Authority of Japan(GSI). Since then, the database has been updated every year based on new topographic maps as well as information from the Ministry of Land, Infrastructure and Transport, prefecture governments, municipalities, expressway companies, and road-related public corporations.

Since 2010, the database has been updated based on the 1:2,500 Fundamental Geospatial Data issued by the GSI .

The database consists of 4748 secondary grid cell※ map data in 2013.

※See Note 1 on page 03

Total Road Length and Total Link Count in the DRM Database

	Total Road Length	Total Link Count
Basic Roads	Approx. 390,000km	Approx. 1.43million
Supplemental Roads	Approx. 520,000km	Approx. 3.91million
All Roads	Approx. 910,000km	Approx. 5.34million

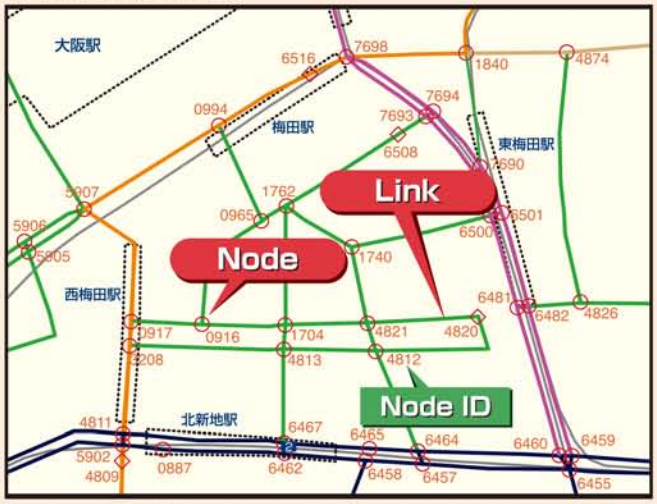
Note: The count of links refers to divided highways; both directions are included in one link. (As of March 31, 2013)

04 Data Model of Road Networks

In the DRM Database, road networks are depicted as combinations of "nodes" and "links" as illustrated in the figure right. A unique ID number is assigned to each node and each link.

- **Node : An intersection or other necessary nodal point of the roadway network.**
- **Link : A road segment between two nodes.**

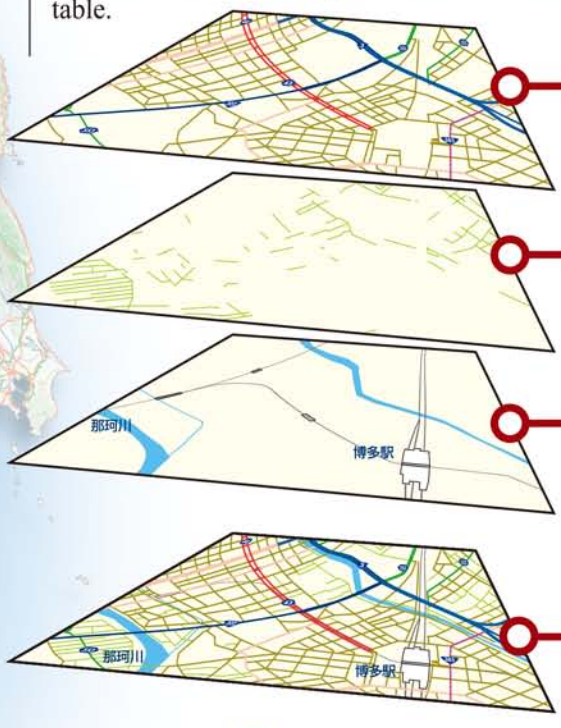
● Nodes and Links



Note: A link ID number consists of the ID numbers of the nodes on both ends of the link, starting with the smaller ID number. Link ID numbers and supplemental roads are not shown on this illustration.

05 Hierarchical Structure of Database

The data is classified into categories as shown in the figure below. Each category consists of several data types which have contents of many items as shown in the right table.



Basic road network data

Roads of the prefectural level and higher (expressways, national highways, and prefectural highways), other roads at least 5.5 meters in width, etc.

Supplemental road network data

Roads at least 3.0 meters in width, other than basic roads

Cartographic background data

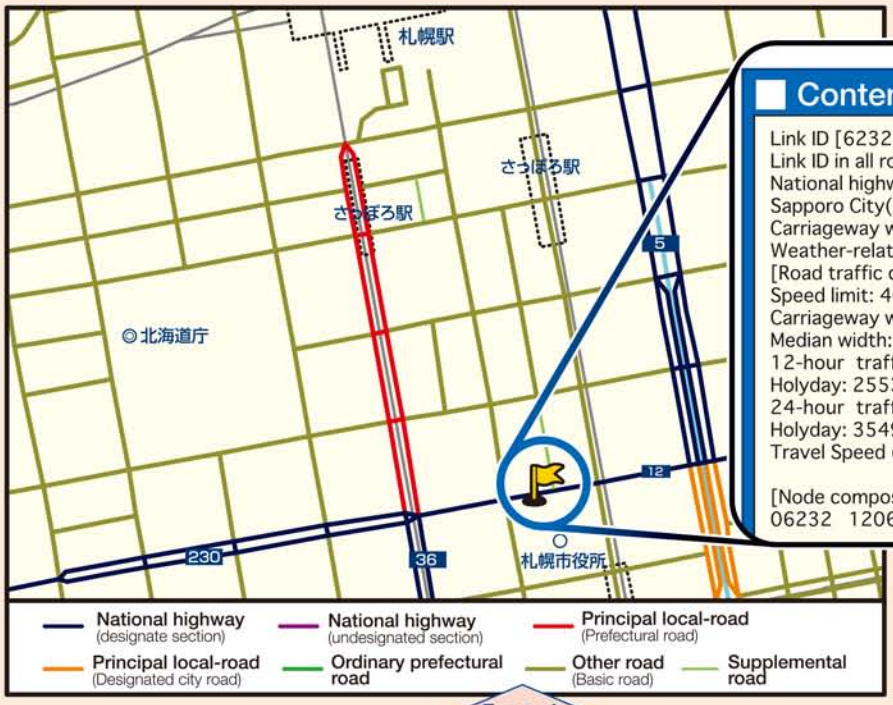
Rivers, administrative boundaries, railroads, facilities, place names, etc.

All data

Combining all basic road data, supplemental road data, and background data

06 Example of Contents of Link Data

The data contents corresponding to the link marked by a yellow flag in the figure below is shown in the right box.



Contents of the link data

Link ID [62326233] [M644142]
Link ID in all road network 0623212068
National highway (designate section) No.12
Sapporo City(1100) Link length 133(m)
Carriageway width more than 13m
Weather-related traffic restriction: non [0 mm]
[Road traffic census] 01300120010 number of lanes: 4
Speed limit: 40 km/h
Carriageway width: 13.0m
Median width: 1.0 m
12-hour traffic volume Weekday: 28749 vehicles
Holyday: 25539 vehicles
24-hour traffic volume Weekday: 40249 vehicles
Holyday: 35499 vehicles
Travel Speed (at peak times): 21.0 km/h

[Node composition]
06232 12068

Example

Category	Data type	Contents (There are also additional data items for use by road administrators.)
Header	Header	Secondary grid cell codes (see Note 1), base map used, earth's magnetic declination, actual cell perimeter lengths, date each datum was updated ,etc.
Basic road network data	Node data of basic road network	Node ID, location coordinates, node type, number of connecting links, connecting node IDs, intersection name, number and destinations of connecting ferry routes, etc.
	Link data of basic road network	Link ID (node ID numbers of each end), administrator code, road type, route number, overlapped route information, municipal area code, link length, width classification, condition of use, types of weather-related traffic restriction zones, vehicle weight, height and width restrictions, number of lanes, carriage-eway width, width of narrowest carriageway portion, median width, median extension length, 12-hour traffic volume, travel speed (at peak times), speed limit and other traffic regulations, coordinates of interpolation point locations, etc
	Feature data of tunnel, bridge and so on	Location within basic road link, name, length, etc. of structures such as a bridge, elevated highway, tunnel, avalanche tunnel, grade crossing, pedestrian overpass, toll gate, and so on.
	Beacon location data	Beacon type, ID number, location, link IDs where the beacon is established, etc.
Supplemental road network data	Node data of supplemental road network	Node ID number, location coordinates, node type, number of connecting links, connecting node IDs, intersection name, etc.
	Link data of supplemental road network	Link ID number (node ID numbers of both ends), administrator code, road type, municipal area code, link length, width classification, number of lanes, traffic regulations, ID number of corresponding basic link, coordinates of interpolation point locations, etc.
	Railroad crossing feature data	Location within supplemental road link, name and length of railroad crossing, etc.
Cartographic background data	Hydrographic data	Shorelines of sea, lake, river (polygon) or stream (polyline)
	Administrative boundary data	Administrative boundaries of prefectures and municipalities including the wards of Tokyo and ordinance designated cities (polyline)
	Railroad location data	Railroad type, location, and underground conditions
	Location data for facilities, etc.	Location, municipal area code, name, etc. of facilities such as a local government office, service area, parking area, roadside rest area, ferry terminal, railroad station, or airport
	Configuration data of facilities, etc.	Outline of a large-scale railroad station, airport, park, etc. (polygon)
	Place name data	Place name, display level reference code, display reference location coordinates and angle, municipal area code, and other data concerning administrative names (city, town, village, ward, etc.), feature names (island, cape, shore, etc.) and road facility names (interchange, harbor, sign, destinations, etc.)

Notes:
1. A national standard regional grid cell of about 10 x 10 kilometer squares.
2. Some data may not yet have been stored for certain types of roads or in certain regions.
3. The content described in this table is based on the National Digital Road Map Database Standards (current standards). Additional data content has been included based on the DRM Standard Format 21. For example, road data on minor roads (from 1.5 to 3 meters in width, with a total length of about 430,000 kilometers as of March 31, 2008) and ferry routes has been included.

Utilization of the Digital Road Map

07 ITS and the Digital Road Map

Intelligent Transport Systems (ITS) are new systems which use the latest communication technologies to create an information network of people, roads, and vehicles for the purpose of resolving road traffic problems such as traffic accidents and congestion. Digital road maps play a fundamental role in many areas of ITS, including the advancement of navigation systems and road management.

Nine Areas of Development for ITS

1 Advancement of navigation systems
2 Electronic toll collection systems
3 Assistance for safe driving
4 Optimization of traffic management
5 Improving the efficiency of road management
6 Support for public transportation
7 Improving the efficiency of commercial vehicles
8 Support for pedestrians, etc.
9 Support for emergency vehicle operation

08 Utilization and Application in Road Administration

Vehicle Information and Communication System (VICS)

In VICS, signals from radio beacons, optical beacons, and FM multiplex broadcasting are received by car navigation systems, and information on traffic congestion, regulations, accidents, parking facility vacancies, etc. is displayed in real time on the screen of a car navigation system in the form of text, simple diagrams, or maps. The DRM Database is stored in the car navigation system, and this is used to display information on congestion, etc. at the road location on the screen.

Reference: Homepage of VICS Center

Special Vehicle Transit Permit Application System

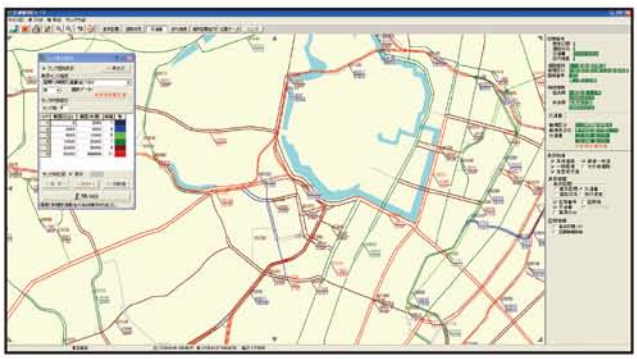
To operate a special (overweight/oversize) vehicle, a permit must be obtained by filing an application with the office of the national or regional government or other entity which manages the roads of the planned route. The DRM Database is used in the online applications system for special vehicle transit permits, contributing to easy transit route selection.

Integrated Traffic Accident Database

Traffic accident data is integrated and analyzed comprehensively by Institute for Traffic Accident Research and Data Analysis (ITARDA). ITARDA records the positions of traffic accidents using the link data of the DRM database.
The Japanese government, local governments and private companies utilize the ITARDA database to prevent traffic accidents.

Road Traffic Census Analysis

The road traffic census is generally performed every five years in the whole conutry. The DRM Database is used for compilation of the survey results, such as computerized preparation of traffic volume maps, and various analyses of congestion and so on.



Sample of road traffic census results in 2010

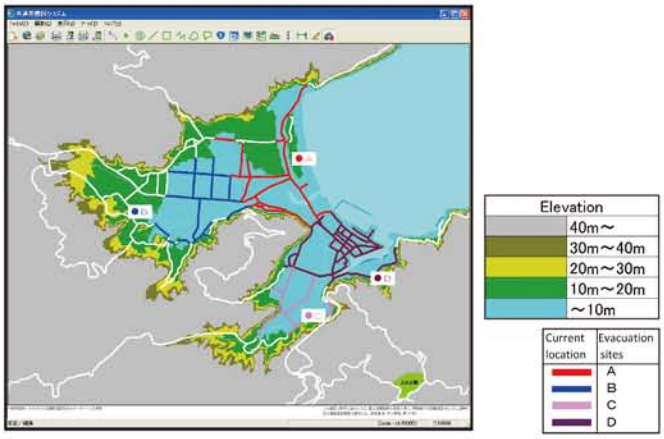
● Examples of other uses (by road administrators and national and regional governments)

- ◆ National Integrated Transport Analysis System (NITAS)
- ◆ Database of programs for traffic congestion control
- ◆ Study of access to suitable candidate sites for parks, etc.
- ◆ Flight path information display system
- ◆ Road maintenance and management system
- ◆ Traffic sign evaluation and management system
- ◆ Visual 3D mapping of road traffic conditions
- ◆ Study on improving spaces for bicycle transit
- ◆ Jurisdictional general purpose maps and pamphlets

09 Utilization and Application in Regional Disaster Prevention and GIS

Evacuation Assistance In Case of Tsunami Warning (In development)

When a tsunami warning is issued, the car navigation system will be able to navigate the vehicle to safer areas arriving in the shortest time if the elevation data of all the roads in the vicinity of the currently driving road are available.
The map is experimentally drawn with especially road elevation data as well as other data of the DRM Database, showing names and locations of evacuation sites located in higher altitudes than the current location.



Information Delivery System In Case of Disasters

In case of earthquakes or natural disasters where road systems are affected, Japan Road Traffic Information Center(JARTIC) has started an information delivery system in 2013 that announces information on roadblocks and traffic congestion. The DRM database is used for location display in this system.

● Examples of other uses related to disaster prevention

- ◆ Disaster and road management map information system
- ◆ Integrated disaster prevention systems
- ◆ Basic data for indices to evaluate the effectiveness of earthquake disaster prevention investment
- ◆ Road earthquake information sharing system
- ◆ Maps of bridge earthquake resistance strength

10 Utilization and Application in Car Navigation and Others

Car navigation systems

These systems accurately match measurements from various sensors and GPS satellites to digital road maps in order to display the current location and indicate the optimal route to the destination. This accurate map information is based on the DRM Database which expresses up-to-date road conditions and road network.

Support and planning system for new store openings

There has been a rapid increase in the number of companies which use GIS for market surveys and planning new store openings. These geographic information systems also make use of the DRM Database.

Publishing electronic maps

The DRM Database is also used for publishing electronic maps which are provided on the Internet or on DVD, CD-ROM, etc. Along with the astounding spread and advancement of the personal computer, electronic maps are becoming more widespread and increasingly diverse, creating new value.

● Examples of other private uses

- ◆ Car location systems
- ◆ Systems to assist safe driving
- ◆ Operation management and logistics management systems

Progress of the Digital Road Map

11 Basic Concept underlying Next-Generation Digital Road Maps

Proposal by the Smartway Project Adivisary Committee "ITS Enters the Second Stage" (Aug. 2004)

Sophistication of digital road map:
"It is desirable for this action to be aggressively promoted with an intention to establish a mechanism that will allow such map data to realize advanced driving support systems and be kept up to date.

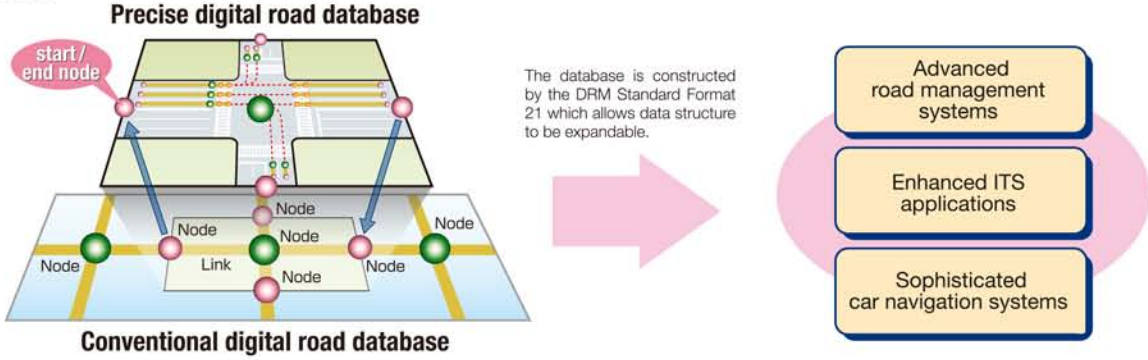
Follow-up on the Proposal (Aug. 2005)

- Creating a mechanism that all road administrators are able to deliver updates on the latest and precise information of roads expeditiously to ordinary users, such as car navigation systems and so on.
- Developing more detailed and easy-to-use digital road map database which will enable to create valuable driving support systems.

Based on the proposals noted above, the National Institute for Land and Infrastructure Management of the Ministry of Land, Infrastructure and Transport established a study group on next-generation digital road maps (chaired by Dr. Ryosuke Shibasaki, Professor of the University of Tokyo). In March 2007 the study group proposed requirements for next-generation digital road maps and a concept for a location referencing system that enables to exchange relevant road information. Following these requirements and concept, DRM has continued to develop and realize a functional precise digital road map and is working to generalize an innovative location referencing system.

12 More Precise Digital Road Map

In the near future, car navigation systems will actualize higher level of driving assistance that is close to autonomous driving in order to assure human safety and a sustainable society. Such navigation systems shall require more precise and more detailed road maps than the conventional one. For instance, lane level intersection maps including pedestrian crossings are necessary to avoid collision accidents. Detailed lane marking with curvature and gradient is necessary to perform advanced driving assistance as well. DRM has generated a pilot database of precise intersection maps and lane level highway digital maps by means of photogrammetry with aerial photographs on scale of 1:8000 and mobile vehicle mapping with GPS/IMU positioning and high-resolution digital video cameras.



13 Activities related to international standardization

ISO TC204 WG3 has been responsible for the standardization of ITS database technology since 1993. Additionally, the DRM Associaton has been technically and financially supporting WG3 as its convener.
In rapidly growing car navigation systems and cooperative systems, geographic information plays an important role. Activities led by the WG3 include the standardization of exchanging format between geographic information providers, compact stored format allowing high-speed search, and specifications for functional requirements/data models/data elements for geographic information.

List of work items

No	Subworking groups Work Items	Contents
ISO 14825	Geographic Data Files - GDF5.0	Standard for data exchange of geographical databases serving as the basis for geographical data used for navigation
TS 20452	Requirements and Logical Data Model for PSF, API and; Logical Data Organization for PSF used in ITS Database Technology	Standardization of data storage methods, such as CD-ROM used for navigation
ISO 24099	Navigation Data Delivery Structures and Protocols	Standardization of data structures and protocols to transmit map data
ISO 17572	Location Referencing for Geographic Databases	Standardization of location reference in case of information exchange between different applications and between geographical databases
ISO 17267	Navigation systems – Application programming interface (API)	Standardization of methods for access to data by application programs like navigation systems
NP 14296	Extension of map database specifications for applications of cooperative ITS	Building function requirements and data models concerning applications of map data bases in cooperative ITS systems (including ADAS).
TS 17931	Extension of map database specifications for Local Dynamic Map for applications of Cooperative ITS	Local Dynamic Map functional requirements and map databases for cooperative ITS
PWI 19297	Shareable geospatial databases for ITS applications	The new framework which enables accessing and sharing of various geography space databases

Japan Digital Road Map Association (DRM Associaton)

14 Profile

Objectives

To develop information technologies on road networks and digital road maps. In addition to the surveying and testing of digital maps, to establish a standard format for such maps, and encourage their wider use, there by contributing to social and economic progress.

Operations

1. Surveys and research, systems development, and standardization for gathering, processing, and supplying digital roadmap information
2. Gathering, processing, accumulating, and supplying digital roadmap information
3. Formulating, updating, managing, and supplying a digital roadmap information database
4. Surveys and research on the use of digital roadmap information
5. International cooperation related to digital roadmap information
6. Operations related to the above activities

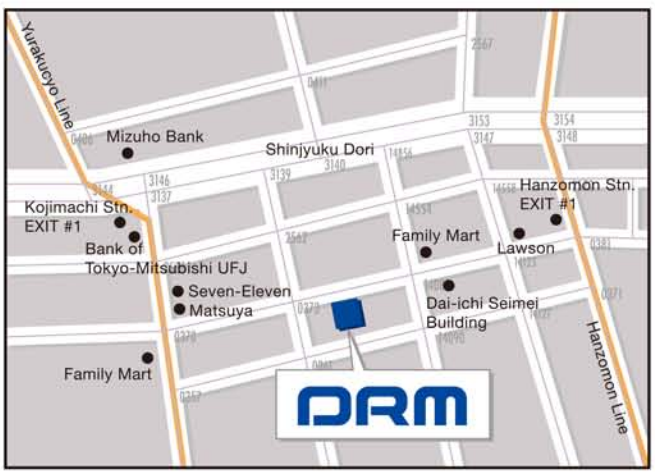
Members

45 companies and organizations (auto manufacturers, electronics and telecommunication manufacturers, map companies, surveying and consulting companies, and other companies and organizations)

Established / August 8, 1988

15 History

1988	・Established the world's first National Digital Road Map Database Standards
	・Started creation of the DRM Database of the basic road
	・Started provision services of the DRM Database
1989	・Started creation of the DRM Database of the supplemental road
1990	・Established the DRM Database Standards for Road Administration
1993	・Participated in ISO/TC204/WG3 activities
1995	・Completed the nationwide coverage of the DRM Database based on the 1:25,000 scale topographic maps
1998	・Established a group to study new DRM standards
2000	・Established the DRM Standard Format 21
2003	・Started creation of the DRM Database of 1.5 ～3 meter wide road
2005	・Started provision services of the DRM Database based on the DRM Standard Format 21
2008	・Started creation of the enhanced DRM data of complex intersections
2010	・Started creation of the DRM Database based on the 1/2500 Fundamental Geospatial Data
2011	・Started creation of the DRM Database based on the World Geodetic System
2012	・Started creation of the DRM Database of altitude data and positions of road submergence



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