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Description of the National Highway Planning Network

B. E. Peterson

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DESCRIPTION OF THE NATIONAL HIGHWAY PLANNING NETWORK

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ABSTRACT

The National Highway Planning Network is a data base of major highways in the continental United States. It is a foundation for analytic studies of highway performance, for vehicle routing and scheduling problems, and for mapping purposes. The network is based on a set of roadways digitized from the National Atlas by the U.S. Geological Survey. It has been enhanced at Oak Ridge National Laboratory by adding additional roads and attribute detail and correcting topological errors to produce a true analytic network. This documentation is intended primarily to assist users of this data base by describing its structure, data elements, and development.

DESCRIPTION OF THE NATIONAL HIGHWAY PLANNING NETWORK

1. OVERVIEW

The National Highway Planning Network is a geographically based analytic network of the major highways in the continental United States. It was developed at Oak Ridge National Laboratory to support analyses of a wide variety of highway transportation issues that require use of a network. Potential uses include studies of highway performance and network design, vehicle routing and scheduling, and social and environmental impacts of transportation. It presently contains approximately 370,000 miles of roadway and will, with varying degrees of accuracy, show the location of these roads and attribute detail about their characteristics.

The checking and correction of information in this network, and the addition of new information, is an ongoing activity, and the completeness of information varies significantly from state to state. This version is therefore a snapshot of a constantly evolving data base. Future versions of this network can be expected to contain more complete attribute detail and additional roadway attributes, as well as additional roads. The appendix shows the current development status of each state subnetwork. Descriptions under individual data items should be consulted to better appreciate data reliability and completeness in areas of interest.

While we have attempted to reduce the incidence of errors, it is unrealistic to expect that all have been caught, especially considering the vagueness of much of the source information and the need for subjective interpretation. Therefore, no user should rely on any data without doing his or her own validity checking.

2. SOURCES

Data included in this network come from several sources. All data have been derived from or checked against information obtained from state and federal governmental agencies.

2.1 USGS DIGITAL LINE GRAPHS

The foundation data was the set of roadways digitized by the U.S. Geological Survey (USGS) from 1:2,000,000 scale plates of the National Atlas, circa 1980. The geographic accuracy of the road alignments in these digital line graphs (DLGs) was very high considering the scale, but it was primarily a cartographic network, suited to automated mapping. Much of the information about road attributes important in analytic studies was limited, missing, or obsolete, such as sign routes. Furthermore, topological details (the way roads are connected) were sometimes excessively generalized for our purposes, especially in urban areas.

2.2 STATE MAPS

We obtained state published highway maps dated some time between 1983 and 1989 as the primary data source for most non-locational data. The typical state highway map shows at least all state highways, indicates distances between major junctions, has urban area inserts, and was published by a state agency. Exceptions are California, Idaho, New York, and South Dakota, where the standard highway maps are privately copyrighted. In New York, detailed Department of Transportation highway maps (1:250,000) were used, but which lacked distance indicators. In California, highway district maps and route logs were used, augmented by USGS 1:250,000 and 1:100,000 scale maps. In Idaho and

South Dakota, state highway agency maps were supplied by the Federal Highway Administration (FHWA) showing routes and functional classes, but not distances. When "state maps" are mentioned in subsequent discussions of individual data items, it is to this set that they refer.

2.3 OTHER MAPS

We had county road maps and highway district maps from a number of states, which were used for whatever detail they could supply, topological and attribute. USGS 1:250,000 and 1:100,000 scale maps were frequently consulted to resolve locational and attribute details. We considered them supplemental sources to be used when the state maps were inconclusive or not detailed enough. FHWA supplied maps for every state showing highway functional classes.

2.4 HPMS

FHWA allowed us access to the Highway Performance Monitoring System (HPMS), which is logically an inventory of highways in the United States supplied by individual state highway agencies. In many states it is possible to translate between individual records and the real roadways they describe. When it was possible, selected attribute information in HPMS was transcribed to network links.

2.5 GEOPLEX CORPORATION

Under contract with FHWA, the Geoplex Corporation digitized most Federal-Aid Primary (FAP) roads in each state that were not included in the USGS network. They used 1:500,000 scale USGS state maps as their source. In addition, they marked links on their own network (which also used the USGS DLGs as its base) which were designated truck routes and FAP routes. We are in the process of incorporating this data into the network; a few states (consult appendix) are complete in this version.

2.6 DEFENSE MOVEMENT COORDINATORS

One of the functions of this data base is to assist military personnel in the management of military movements. State National Guard offices are now being staffed with Defense Movement Coordinators (DMCs) who are familiar with their own states' highway systems and who maintain contact with both state highway agencies and local units. Because of their management responsibilities, they have an interest in correcting errors and maintaining the accuracy and currency of the data. We have benefitted from the oversight of DMCs in California, Florida, Georgia, Illinois, Massachusetts, Ohio, Texas, Virginia, Washington, and Wisconsin.

3. CONSTRUCTION

The base data for this highway network were the 1:2,000,000 USGS digital line graphs. The locational data were edge matched, scissored into state subnetworks, and element identifications were assigned. As later described, initial geographically calculated distances were assigned to each link. In addition, other attribute details that could be deduced from the USGS attributes (e.g., most sign routes, access control, and divided highway flags) were also incorporated.

An initial clean-up pass was made through every state to check or add sign routes and check distances. The most serious topological problems were also resolved at this time. Except for location, attribute editing was done with a text editor. For location, a set of programs were locally written to move links and junctions, adjust their shapes, subdivide original links by establishing new junctions along their length, and add new non-digitized (straight line) links between nodes, new or old. At this stage, new junction locations were estimated visually, either relative to an existing link or at a free-standing new absolute location. Initially, the network contained approximately 320,000 miles. From this point on, the treatment of each state was individual. Several states were test sites for the Army Forces Command convoy management program, and many new links were added at their request as potential convoy routes. Access roads to major military bases were also added, although they have been excluded from this version of the network. In most cases, detailed descriptions of these roads were supplied by DMCs.

In a small number of areas required for a Department of Energy study, the Geographic Data Systems group at Oak Ridge digitized (from 1:250,000 USGS maps) all state highways.

We also embarked on a program, which is still continuing, to include in the network all rural arterials (essentially the Federal-Aid Primary system). Again, new link locations were not digitized, although more care was taken in the location of new junctions. During this second pass through the states, road locations were compared to large scale USGS maps and the more egregious problems were corrected, so many of the road alignments have been changed from the original DLGs. Insofar as our data sources permitted, we attempted to add administrative and functional class indicators to network links. In this network version the second pass has not yet been completed in the District of Columbia, Illinois, and Pennsylvania.

The third stage, which began in 1988, is the inclusion of Geoplex digitized alignments and identifiers for designated truck routes. Although not specifically marked, Geoplex digitized links can usually be identified by the small increment between digitized points (generally near 200 m) and their relatively high sequence numbers in the state subnetworks.

4. LOCATIONAL ACCURACY

Although we have not conducted a systematic study, our general impression based on comparison with large scale maps is that geographic accuracy of the original USGS digital line graph data is about 1200 meters (root mean square). This average includes a number of rural areas where more significant systematic errors occurred. Urban areas, with their high levels of generalization and many competing features causing displacement on the original map plates, also tended to have less than average accuracy.

The first pass of the states, where urban topological problems were untangled, often purchased greater clarity at the cost of minor reductions in locational accuracy, because new junction locations were visually estimated relative to points or links which already had locational problems.

Naturally, new straight line links have much worse accuracy away from their end-points. And their end-point locations, insofar as they were visually estimated sub-dividing points on existing links, can also be expected to be slightly worse than the original USGS standard. Both problems will be overcome as the Geoplex digitization work is incorporated, resulting in accuracies modestly superior to the original (excepting the remaining straight line links, of which there will be many).

In evaluating locational accuracy, it is important to remember that our primary goal was a topologically correct analytic network. We did not wish to throw away locational information given to us by USGS, but it was usually a secondary concern. In future applications requiring a higher level of locational accuracy, we will decide at the time whether local digitization or the incorporation of 1:100,000 scale USGS digitized data is warranted. While this network can certainly be mapped, it would be misleading to regard it as a cartographic data base because of the large number of non-digitized links.

5. TOPOLOGICAL ACCURACY

One of the purposes of this network is to serve as the base of a roadway inventory system. The accurate representation of roadway connectivity is therefore very important to facilitate the automated assignment of inventory data to the network. There are, however, limits on the fidelity of the network's topological representation imposed both by source material and by our desire to reduce maintenance problems by avoiding complexity. In general, our topological resolution standard was 0.2 miles. That is, if two junctions are closer than 0.2 miles apart, they will be represented by a single node in the network. Network matching procedures which attempt to construct equivalency tables between this network and finer resolution geographic roadway data must take this generalization into account.

Resolution can, of course, be much worse than this standard. Most state highway maps will typically not resolve junctions less than a half mile apart; if that map was our best source material, they will not be resolved in the network either. Most interchanges are represented by single nodes as well, even though they may contain several ramps much longer than 0.2 miles. A very small number of interchanges have connecting links in the network representing a collection of ramps, most commonly on toll roads, where a single node would have caused excessive displacement of the through routes. A related consequence of this topology standard occurs when a route is carried by parallel one-way streets, known as couplets. This is a common occurrence in urban areas, but because the two real components of a couplet are seldom more than two city blocks apart, they fall within the resolution standard, and so are represented by a single link.

6. NETWORK FILE STRUCTURE

Two files comprise this network: one describing links and the other nodes. Both use 80-byte card image logical records. This version contains approximately 44,000 links (written on 200,000 records) and about 28,000 nodes.

The node file contains a single record for each node referenced in the link file as a link end-point. Each record contains the 7-digit node number (columns 2:8), the node's longitude and latitude (columns 9:32), and an alphabetic node name (columns 33:60) if one has been assigned, in format (1X,I7,2F12.4,A28). Roughly half of the nodes have been assigned names of nearby towns, geographic features, or freeway exit numbers.

As is true for link IDs, the first two digits of the node number are the FIPS code of that node's state. However, nodes on state boundaries begin with a prefix of "00." No individual link will cross a state boundary, and most (but not all) boundary nodes will connect links in two separate states. When node names are used, the first two characters are the state postal abbreviation. The longitude and latitude of the node will be the same as the first or last digitized point in the location chain of every link that uses the node as an end-point.

The link file contains a variable number of contiguous records describing each link. Every link starts with a header record containing link attributes except for location. The fields are described in the following section. Following the header are as many card image records as necessary to hold the sequence of longitude/latitude pairs that describe the digitized alignment of the link, directed from the A-node to the B-node. There are four pairs per record in format (8F10.4). The number of pairs associated with the link is the last field on the header record. Non-digitized links without alignment information will have only two pairs of coordinates.

A typical FORTRAN code for recovering the digitized chain would be:

```
      REAL*4     XCOORD(2,500)
C
      OPEN(41)
 21   READ(41,213,END=29) LINKID,NPOINT
 213  FORMAT (1X,I8,T73,I7)
      READ(41,215) ((XCOORD(I,J),I=1,2),J=1,NPOINT)
 215  FORMAT (8F10.4)
      . . . processing of link information . . .
      GOTO 21
 29   CLOSE(41)
```

In this example XCOORD(1,8) would be the longitude of the 8th point in the chain and XCOORD(2,8) the latitude, in degrees and decimal fractions of a degree, using the convention that longitudes west of Greenwich are negative. At the present time, no link's chain has more than 300 points in it.

7. LINK HEADER RECORD FIELD NAMES AND LOCATIONS

Name	Format	Columns
		1
(1) Link ID	(I8)	2:9
(2) Sign route	(A6)	10:15
Sign route 2	(A6)	16:21
Sign route 3	(A6)	22:27
(3) Length	(F5)	28:32
(4) Heading	(A1)	33
(5) Urban flag	(A1)	34
(6) One-way flag	(A1)	35
		36
(8) Median	(A1)	37
(9) Access control	(A1)	38
(10) Number of lanes	(I2)	39:40
(11) Traffic modifier	(A1)	41
(12) Toll flag	(A1)	42
		43
(14) Truck route flag	(A1)	44
		45
(16) Bit field	(Z1)	46
1 - Major highway extension		
2 - Major highway exclusion		
4 - Tunnel flag		
(17) Pavement type	(A1)	47
(18) Administrative class	(A1)	48
(19) Functional class	(A2)	49:50
		51:55
(21) Status	(A1)	56
		57:58
A-node	(I7)	59:65
B-node	(I7)	66:72
Num of points	(I7)	73:79

The columns denoted as "bit fields" each contain a single hexadecimal digit representing four bits for four binary (yes/no) flags. For example, the digit 3 represents 0011 and D represents 1101. A blank is the same as a zero.

8. LINK DATA ELEMENT DESCRIPTIONS

8.1 LINK ID

Conceptually, the link ID is an 8-digit integer that uniquely identifies a link. Analysis and editing software will generally use link IDs as pointers and cross references. The link ID is composed of three parts:

8.1.1 State Prefix

The first 2 digits are the FIPS code of the state the link is contained in, from 01 to 56, and, therefore, provide a means of dividing the national network into subnetworks by state.

8.1.2 Link Sequence Number

Originally, within each state, the links as provided from the USGS file were simply numbered from 1 on, in the same order (excluding links entirely outside the state boundaries). New links which were not sub-divisions were added to the bottom of the file, incrementing the sequence number by one. There will, however, be some small gaps in the sequence. Five digits are provided for the sequence number even though the largest is presently less than 3000, i.e., the leading digit of the sequence number is always 0. [This digit may be used for some other purpose in the future.]

8.1.3 Sub-Division Number

During the editing process, when a parent link is sub-divided into several daughter links, those daughters will retain the same sequence number, but will be assigned unique sub-division numbers from 1 to 9 in the last character position of the link ID. Links which have not been sub-divided will have a blank in this position, implicitly a sub-division number of 0. [If the program used to read the file also treats link IDs as integers, you must take care that a zero is read for this blank, or else uniqueness and interpretability will be lost.] The sub-divisions are not necessarily in order relative to the original parent. Many parent links have been (or will be) divided into more than 9 daughters; when this happens two new "daughter" links with different sequence numbers are established from the parent, and they are sub-divided. In rare cases, the daughter links will be parallel roads with similar shapes but slightly displaced locations.

8.1.4 Compatibility

Link ID alone will not be sufficient to insure compatibility with future versions of this network, since they will sometimes change during editing and modification, either modestly (as when a parent link is sub-divided) or substantially (as when links are combined, moved, replaced, or renumbered for efficiency reasons). Node numbers do have relative permanence, and they should be used to designate network elements instead as far as possible. If users of this network have compelling reasons for changing the link identification scheme (for instance, going to pure sequential numbering), a substantial loss in the ease of establishing compatibility with future versions can be expected, but not completely lost provided node numbers (or cross references to them) are retained. As was noted, even retaining link IDs is no assurance that element equivalencies will be preserved, particularly when topological restructuring occurs. Before concluding that links with similar IDs in different network versions are the same, a check must be made of end-point nodes and possibly even absolute location. However, the vast preponderance of link IDs through the sequence number can be expected to point to what is substantially the same real section of roadway in all future versions.

8.2 SIGN ROUTE

There are three sign route fields, in case multiple routes jointly use the same road. The first character indicates the type of sign route, the next five indicate the route number or road name, left adjusted with blank fill on the right. A qualifier may follow the route number. Normally, multiple sign routes are listed in order of priority of the type, then the qualifier, then the route number, unless there is evidence that the state recognizes a different cardinal route on a link. [For instance, I-59 takes precedence over I-20 in Mississippi and Alabama by state choice, and the mileposts follow the I-59 milepoint sequence.]

8.2.1 Sign Route Types

I - Interstate. Posted as an Interstate route, but not necessarily on the Federal-Aid Interstate system.
U - U.S. route.
S - State route.
T - Secondary state route. Some states have a second-level state-wide route structure with an independent numbering scheme. Used in Texas for loop and spur routes. Also used in several states for state inventory or Federal-aid route identifiers not normally posted.
J - Interstate related route, such as business routes and ramps.
C- County route number or road name. Note that there is sometimes ambiguity about whether a route should be designated county or state secondary. Used in Texas for farm (FM) routes.
L - Local road name. Usually abbreviated, as LOGLES for Oglesby Road. Local directional qualifiers are usually not added: North 4th Street would be represented as L4-ST.
P - Parkway.
V - Federal reservation road. Used in national parks and forests, Indian reservations, and military reservations.

8.2.2 Sign Route Names

Commonly used route qualifiers trailing the route number:

N, S, E, W
A - Alternate.
BR - Business route or business loop.
BY - Bypass.
SP - Spur.
LP - Loop.
RM - Ramp.
PR - Proposed.
T - Temporary.
TR - Truck route.
Y - Wye.

The state may incorporate letters into the sign route; our dual intent is to make the physically posted route identifier recognizable and to have one of the sign routes match the state route identifier used in its inventory system.

In many cases the route or name could not be identified from the maps we were working with. An "X", possibly with a qualifier, was then used, e.g., CX-MAD for unidentified Madison County road. An "X" may also be used if the link is a collection of several differently named roads, particularly in cities.

A trailing dash may follow the route name if that name applies to only part of the link. A trailing plus sign may be used for the two street names of a couplet represented as a single bi-directional network link.

8.2.3 Reliability

Reliability varied from state to state depending on the quality of the state highway map and whether we had county-level maps to work with. In general, state route numbers and above have been carefully checked in all states as of 1986 or later.

8.2.4 Sources

Primary: State highway and highway district maps. Secondary: County maps, USGS large scale maps, CA route log, HPMS.

8.3 LENGTH

The length of the link, in miles. While indicated in tenths with an explicit decimal point, accuracies are generally no better than a mile. Distances were estimated by first calculating an imputed distance from the sum of individual digitized segments of the link. That imputed distance was then compared to an indicated distance on the state highway map. If significantly different, the indicated distance was substituted. "Significant" usually meant about a mile and a half. The preponderance of links met the comparison test because, even though locational accuracy is only 3/4 of a mile at each end, there is a high local correlation in the direction and magnitude of errors.

Initial imputed distances included an adjustment factor to compensate for the generalization of curves by chords during digitization and for slopes. The most commonly used adjustment factors ranged from 0 percent to 4 percent. These were determined from tests on Interstate highways using HPMS, where it was possible to obtain precise distances between county boundary crossings. This was compared to imputed distances using the digitized segments, and the nationwide average discrepancy was about 2.5 percent. The factor varies due to the amount of curvature of the road, which in turn depends on topography and road class. In the Midwest, the average is lower and in mountainous areas the average is much higher.

When new non-digitized links were added, distances were most commonly transcribed from a highway map or other source. Sometimes, especially if the link was short and if there was confidence about end-point absolute locations, a circuity factor for the link would be estimated and a geographically imputed distance used instead.

Many other supplemental sources of distance information were consulted in special circumstances that can give accuracies of better than a half mile. In many areas, particularly urban, distances were measured on large scale maps. Additional accuracy was possible where we had county maps with indicated distances. In California, state route logs were used to check or transcribe distances. In other limited circumstances, it was possible to unambiguously determine distances from HPMS.

In Idaho and South Dakota, where no source of individual link distance information existed that was not privately copyrighted, links with imputed distances that failed comparison tests were calculated by regression equations using location in the state, the degree of curvature, and roadway characteristics, or else circuity factors were visually estimated. In New York, most of these roads were either manually measured from 1:250,000 scale maps or else circuity factors were estimated.

Unfortunately, the pedigree of the distance data cannot be determined from the link file. It should also be recognized that state highway map distance indicators are often ambiguous. In general, users should count themselves lucky if the indicated distance on any particular link is within one mile or 3 percent of the true value, whichever is worse. Although no systematic study has been done, our best guess is that the nationwide average error for distances is an underestimate near one-quarter percent, while the standard error for a link is between one-half and one mile. Clearly, this data is not adequate for rating purposes.

8.4 HEADING

This is the direction (N, S, E, or W) that one travels along the link from the A-node to the B-node. Generally, it will match the heading physically posted along with the sign route at the roadside rather than a geographic heading, but the geographic heading may be used to avoid ambiguity when multiple sign routes use the link or when geographic and posted directions are reversed. For instance, a link record will indicate you are heading east on I-81 near Wytheville, Virginia, when the roadside signs will indicate north on I-81 and south on I-77.

8.5 URBAN FLAG

This flag will indicate a subjective judgement about the degree of urban congestion which we use to influence routing choices.

U - Urban.
V - Urban bypasses. Generally circumferential routes.
S - Small urban or towns.
T - Partially urban. That is, part of the link is subject to congestion effects limiting speed. Operationally, we treat links flagged "T" as having 0.5 miles of their length subject to urban speed reduction.

8.6 ONE-WAY INDICATOR

1 - Traffic flow permitted from A- to B-node only. At the present time, all parallel one-way streets are generalized as single two-way links, but this indicator will allow future flexibility.
2 - Bi-directional link.

8.7 MEDIAN

M - Divided highway (with median).
C - Undivided (i.e., "centerline").
F - Ferry.

Source State highway maps, supplemented by HPMS.

8.8 ACCESS CONTROL

U - Uncontrolled access.
G - Partially controlled access (with some at-grade intersections).
I - Fully controlled access. All intersections are grade separated interchanges.
F - Ferry.

Source State highway maps, supplemented by USGS large scale maps and HPMS. There is often ambiguity about the definition of partially controlled access.

8.9 NUMBER OF LANES

Generally there are either two or four lanes representing all multilane roads.

Reported as 0 for ferries. In some instances there will be links marked two-lane divided representing a collection of access ramps.

Source State highway maps, supplemented by HPMS. Most maps will not distinguish between two-lane and multilane undivided highways, hence many roads can be expected to be misreported. In rare cases an actual value greater than four was reported by a state DMC or transcribed from HPMS, but for consistency it would be wise to treat all otherwise identical roads with four or more lanes the same way.

8.10 TRAFFIC MODIFIER

In order of priority:
Z - No vehicles (generally a passenger ferry).
P - Closed to public use.
C - Commercial traffic prohibited.
H - Hazardous materials prohibited.
T - Large trucks prohibited.

Q - Occasionally closed to public.
L - Local commercial traffic only.
W - Normally closed in winter.

Completeness Not systematic in any state; a blank field is no indication that a traffic restriction does not exist. This information has usually been added on an exception basis; that is, to solve a detected routing problem. Parkways and national parks were assumed to be restricted. Roads flagged in HPMS were also included.

8.11 TOLL FLAG

T - Toll road.

Source State highway maps, supplemented by HPMS.

8.12 DESIGNATED TRUCK ROUTE

A - State designated truck route under provisions of the Surface Transportation Assistance Act. Consult appendix for completeness.

Source Federal Register, HPMS, and subjective assumptions when new parallel roads have been opened. All Interstate routes are assumed to be included unless Federally exempted.

8.13 MAJOR INTERCITY HIGHWAYS

8.13.1 Major Highway Extension

A "major intercity highways" subnetwork may be constructed by using all Federal-Aid Interstate links, all rural principal arterials and urban expressways (functional classes that end in "2" or "3") not specifically excluded by bit 16-2, and links with this flag, bit 16-1, set to 1. These are generally urban principal arterials and other "gap fillers" deemed to be logical extensions of rural principal arterials. This subnetwork depends on proposed routes (not yet open to traffic) for its connectivity. Many of the included routes are parkways closed to commercial traffic, particularly in New York.

8.13.2 Major Highway Exclusion

Links with bit 16-2 set to 1, which would otherwise be included in the major highways subnetwork because of their functional classes, were deemed unnecessary.

8.14 TUNNEL FLAG

If bit 16-4 is set to 1, a tunnel is known to exist on the link, generally because it was shown on a highway map. Absence of a flag is no guarantee of the absence of a tunnel.

8.15 PAVEMENT TYPE

P - Paved.
Q - Secondary paved. Generally a subjective determination that through traffic should be discouraged, because of the road's local nature or poor quality.
G - Gravel, or otherwise indicated as below paved quality.
D - Dirt.
F - Ferry.

Source State highway maps, for unpaved roads. The P/Q distinction considered in part average daily traffic and lane width from HPMS where available or an indication of a lower road class on the state highway map or USGS map. Occasionally the distinction was made to correct a routing a state DMC declared unrealistic. But there were no hard rules covering the choice.

8.16 ADMINISTRATIVE CLASS

I - Federal-Aid Interstate.
P - Federal-Aid Primary.
S - Federal-Aid Secondary.
U - Federal-Aid Urban.
T - Combination of "S" and "U." That is, part of the road is FAU inside an urbanized area boundary and the rest is FAS. In some cases, it is a combination of "N" and "S" or "U" on different sides of an urbanized area boundary (common in Arkansas and North Carolina).
N - Not on a Federal-Aid system.
F - Direct Federal system.

If blank, administrative class is unknown. The confidence that the road is not FAP depends on the state. With minor (mostly urban) exceptions, the FAP system now open to traffic is completely represented in the following states, as determined from examination of HPMS or FHWA supplied large scale state maps:

AL, CA, CO, CT, GA, ID, IA, KS, KY, MD, MN, MS, MO, MT, NE, NV, NH, NJ, NY, NC, ND, OH, OK, OR, RI, SC, SD, TN, TX, UT, VT, VA, WA, WV

FAP coverage is believed near complete and correct, as determined from a national map of the FAP system, in the following states:

AZ, AR, DE, FL, IN, LA, ME, MA, MI, NM, WI, WY

States with only limited FAP indicators are:

DC, IL, PA

Administrative and functional classes are generally not indicated on a small number of short connecting links identified as ramps or local surface streets in the sign route field. Consequently, when constructing subnetworks based on these attributes, connectivity at some legitimate junctions may be lost unless tests for the existence of these connectors are made.

8.17 FUNCTIONAL CLASS

Functional class identifiers use the standard codes in HPMS, plus special codes with a leading blank (represented below as an underscore, "_") to indicate combinations where part of the link is inside and part outside an urbanized area boundary. As a rule of thumb, if less than 10 to 20 percent of a link's length AND less than 3 miles of a link is of a different functional class, a combination code will not be used. [The same rule applies to administrative class.] It should be noted that it is often difficult to be precise about the location of urbanized area boundaries without a current large-scale map that will show them. The typical situation is that boundary locations were estimated from milepoints in HPMS.

Rural	Urban
01 - Interstate.	11 - Interstate.
02 Principal arterial.	12 - Other expressway.
	13 -
	14 - Principal arterial.
05 - Major arterial.	15 -
06 - Minor arterial.	16 - Minor arterial.
07 - Major collector.	17 - Collector.
08 - Minor collector.	
09 - Local.	19 - Local.

Combination		
_1 -	01 & 11	
_2 -	02 & 12	
_3 -	02 & 14	
_4 -	06 & 12	05 & 12
_5 -	06 & 14	05 & 14
_6 -	06 & 16	07 & 14
_7 -	07 & 16	07 & 17

The functional class "05" is used only in only a few states, which distinguish an intermediate rural arterial class. These roads are reported as "06" in HPMS.

Some states use codes of "13" and "15" in HPMS. The former are generally urban extensions of rural principal arterials, but both probably fall under the FHWA definition of urban principal arterials (class "14").

All roads which are in whole or part rural principal arterials will have functional class indicated, and coverage is complete as of 1984. There are no rural principal arterials open to traffic that are missing from the network. As a practical matter, rural principal arterials can be identified by codes of "02", "_3", and "_2".

Beyond that, the completeness of functional class indicators varies by state (consult appendix). Functional classes below "07" and "16" are rarely indicated because, even if reported in HPMS, their location and identity are usually impossible to estimate. There are very few roads in the network in these low functional classes anyway. In many states, functional class is not reported for Interstates.

Functional class will be indicated for all links that are rural arterials in the following states. Coverage of rural arterials is also substantially complete in these states, but most urban minor arterials and many urban principal arterials off the FAP system will have no network representation.

AL, CA, CO, CT, GA, ID, IA, KS, KY, MD, MI, MN, MS, MO, NE, NV, NJ, NY, NC, ND, OH, RI, SC, SD, TN, TX, VT, VA, WA, WV

Source HPMS and large scale state or highway district level maps supplied by FHWA.

8.17 STATUS

O - Open to traffic.
U - Under construction.
P - Proposed. [Often reasonable guesses for route alignments that will match distances in HPMS.]

APPENDIX

National Highway Planning Network
STATUS OF STATE SUBNETWORKS
3 May 1990

State	Algn	AdmPO_	Func1357_	Mjr Trk		Miles	Links	Notes	Update	
AL 01	G	H 820	H 12510	T	J	9.6	13		91	94
AZ 04	.	N 811	. 02413	.	J	6.0	3		8	95
AR 05	.	N 8.2	. 134.2	.	J	7.9	7	active	8	98
CA 06	G	H 910	H 23510	T	J	16.1	16		91	94
CO 08	G	H 540	H 12340	T	J	8.8	7		92	94
CT 09	G	H 910	H 23510	T	J	2.0	5		99	
DE 10	.	N 7.3	M 13313	.	J	0.6	2		8	9A
DC 11	.	. 2.8	. ....A	.	J	0.1	0	active	8	9A
FL 12	.	N 7.3	. .21.7	.	J	11.9	17		8	9A
GA 13	G	H 730	H 12430	T	J	16.0	27		93	94
ID 16	G	H 730	H 13230	T	J	5.0	4		04	
IL 17	.	. 6.4	. 204.4	.	J	10.2	13		8	95
IN 18	.	N 8.2	. .20.8	.	J	7.4	10		8	9A
IA 19	.	H A00	H .3601	.	J	9.9	11		8	9C
KS 20	G	H 810	H 13410	T	J	10.6	11		94	
KY 21	.	H 630	H 12330	T	J	7.3	10		8	95
LA 22	.	N 604	. .2206	.	J	7.1	8		8	9A
ME 23	.	N 631	M 12332	T	J	3.5	3		8	01
MD 24	.	H 911	H .2502	.	J	2.9	6		8	94
MA 25	.	N 7.3	. 222.6	.	J	2.6	5		8	99
MI 26	G	HN 901	H 13321	T	J	9.7	12	MI	95	
MN 27	G	H 91.	H 1351.	T	J	11.8	13		01	
MS 28	.	H 811	H .2512	.	J	8.2	10		8	94
MO 29	.	H 811	H .2512	.	J	9.7	11		8	9A
MT 30	.	N 901	. 13401	.	J	7.7	4	active	8	9A
NE 31	.	H 910	H 13510	.	J	8.6	8		8	94
NV 32	G	H 55.	H 11241	T	J	5.4	3		04	
NH 33	.	H 7.3	H 124.3	T	J	1.8	3		8	94
NJ 34	.	H 730	H 12510	T	J	2.9	7		8	01
NM 35	.	N 5.5	. .2..8	.	J	8.5	5		8	9A
NY 36	G	H 820	H 12520	T	J	12.4	25		03	
NC 37	.	H 640	H 13331	.	J	9.7	15		8	01
ND 38	.	H A00	H 12700	.	J	6.4	5		8	9C
OH 39	.	H 820	H .2512	.	J	10.2	16		8	9A
OK 40	.	N 703	. .2107	.	J	9.2	9		8	9A
OR 41	.	N 8.2	. 041.6	.	J	6.9	4		8	94
PA 42	.	. 4.6	. .3..7	.	J	8.8	12		8	9A
RI 44	G	S 721	S 12511	T	J	0.6	2		94	
SC 45	.	H 910	H 12510	.	J	7.4	12		8	94
SD 46	.	H 9.1	H 135.1	.	J	6.9	5		8	9C
TN 47	.	H 901	H .16.3	T	J	8.3	12		8	01
TX 48	G	H 73.	H 1334.	T	J	30.1	30		98	
UT 49	.	H 712	. .1..9	.	J	5.1	4		8	9A
VT 50	.	H 712	H .2414	.	J	2.0	3		8	99
VA 51	.	H 812	H .2413	T	J	8.5	13		8	05
WA 53	G	M 811	M 13411	T	J	7.2	7		8A	94
WV 54	.	H 621	H .1422	T	J	4.5	5		8	05
WI 55	.	N 8.2	M 14501	T	J	10.4	13		8	9C
WY 56	.	N 712	. .2423	.	J	5.8	3	active	8	

Algn - G Geoplex digitization included.
Adm - Administrative class.
H From HPMS.
N From national system map.
S From state publication.
. No reliable information.
PO_ columns: Percentage of mileage (multiple of 10) in FAI/FAP; other classes; and unknown. ["A" is > 95%; "." is < 0.5%; "0" is 0.5 to 5%]
Func - Functional class.
H From HPMS.
M From special state map.
S From state publication.
1357_ columns: Percentage of mileage in functional classes ending in 1; 2 and 3; 4, 5, and 06; 16, 7, 8, and 9; and unknown.
Trk - T State designated truck routes flagged.
Mjr - J Major highways subnetwork inclusions and exclusions flagged.
Miles - Road mileage in subnetwork, in thousands. [Includes ferries]
Links - Number of links in subnetwork, in hundreds.
Update- Year/month of last major structural revision and last minor revision. [94=1989/April; 0B=1990/November]

Notes: MI - Many roads indicated as FAS or FAU with functional classes of 07 or 16 in HPMS (1984) are shown as FAP on the national map. They are marked FAP with their HPMS functional codes in the link list.
active - The state is currently undergoing major structural revision, and much attribute data is likely to be incomplete.

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