Consultancy Services for

Orissa Road Asset Management System (O-RAMS)

Workshop on

Conceptual Design & Data Collection

Works Department

Government of Orissa

Consultant

LEA Associates South Asia Pvt. Ltd. (LASA), India

in joint venture with

LEA International Ltd. (LEA), Canada

in association with

Geo InfoSpace Private Ltd. (GIPL), India

Overview of the Project

- Part of Orissa State Road Project (OSRP)
- Asset Management System (AMS) for the State Road Network
- Three-year project includes
  - Data collection and system set-up (Year 1)
  - Data collection (Year 2)
  - Support (Year 3)
- Training and skill transfer
  - On-the-job training in Orissa (Year 1 & 2)
  - Exposure visit to other States (Year 2)
  - Exposure visit to Canada (Year 2)

Definition of Asset Management

Asset management is a systematic process of maintaining assets cost-effectively

It combines engineering principles with sound business practices and economic rationale

It provides tools to facilitate a more organised, logical and flexible approach to decisions for handling both short-and long-term planning

Drivers of AMS

- Need to know the extent and condition of asset
- Limited budget for preservation
- Justification of demand for funds
- Best utilisation of public funds for public good
- Transparency and credibility in decisions
- Decision making – priorities and policies
- Feedback – effectiveness of actions

  – what should change ?

Data

Data Collection for O-RAMS

By OWD

- Pavement, culvert and bridge inventory on NHs, SHs, MDRs & ODRs (20% to be verified by Consultant)
- History of pavement construction and maintenance on SHs & MDRs in the last 5 years
- Right-of-way features

By Consultant

- GPS survey on NHs, SHs, MDRs & ODRs
- Pavement and bridge condition on SHs and MDRs
- Road roughness survey on SHs and MDRs
- BBD survey on SHs and MDRs
- Traffic volume survey (200 locations) on SHs and MDRs
- Axle-load survey (30 locations) on SHs and MDRs

Data Collection Chart

Data Type	Consultant	OWD	Methodology/Comments
GPS Referencing	Year 1 : 18069 km	Nil	Data collected with a handheld GPS receiver
Inventory of Pavements, Culvert, Bridges	Year 1 : 3,614 km (field verification)	Year 1: 18,069 km	20% verification in the field by the Consultant. If any discrepancy, the Client to provide updated data
Roughness on Paved Roads Using ROMDAS	Year 1 : 8,163 km	Year 3: 8,163 km	Road roughness, expressed in IRI, measured using the ROMDAS
Surface Distress Indicators	Year 1 : 8,163 km	Year 3: 8,163 km	Four deficiency types, three severity and extent, by visual inspection

Data Collection Chart…Contd.

Data Type	Consultant	OWD	Methodology/Comments
Pavement Strength	Year 1 : 6,122 km	Year 2: 2,041 km Year 3: 2,041 km	Benkelman beam test every 500 m
Bridge Condition	Year 1: Major (300), Minor (1,350)	Year 3: 1,650	Condition rating (four levels of damages) of various elements
Traffic AADT	Year 1: 200 locations Year 2: 200 locations	Year 3: 200 locations	3-day vehicle count on SHs and MDRs
Traffic Axle-Loads	Year 1: 30 locations	Year 3: 30 locations	Axle-load surveys at 30 locations on SHs and MDRs

Asset Inventory

Location Referencing

- Garmin GPSMAP 78s used as mapping hand-held instrument
- Positional accuracy of 2-5 m
- Records locations of various roadway attributes while travelling along the road
- Automatically records center line of road at regular distance or time interval (every 1 second)

GPSMAP 78s


Internal antenna
MCX connector for external GPS antenna (under weather cap)
Serial port (under weather cap)
Keys
mini-USB port (under weather cap)
Display
Battery compartment
microSD™ card slot (under batteries)
GARMIN

GIS Features Captured

Sl. No.	Captured Feature	Description
1	Centre-Line	Captured automatically every second
2	Kilometer Stone	At exact location of it
3	Cross Road/Junction	Center point of the crossing/junction, and the side, L and/or R
4	Culvert	Centre point of the culvert
5	Bridge	Centre point of a minor bridge; or both ends of a major bridge
6	Village	Beginning and end of the village
7	Pavement Surface	Where surface type changes, e.g., from BT to CC and vice versa Where pavement width changes, e.g., single to intermediate lane
8	Land Use	Where the land-use changes, and the type on both sides

GPS Referencing: Survey Format (Sample)

(141)

ORISSA ASSET MANAGEMENT SYSTEM (O-AMS)

GPS REFERENCING SURVEY SHEET

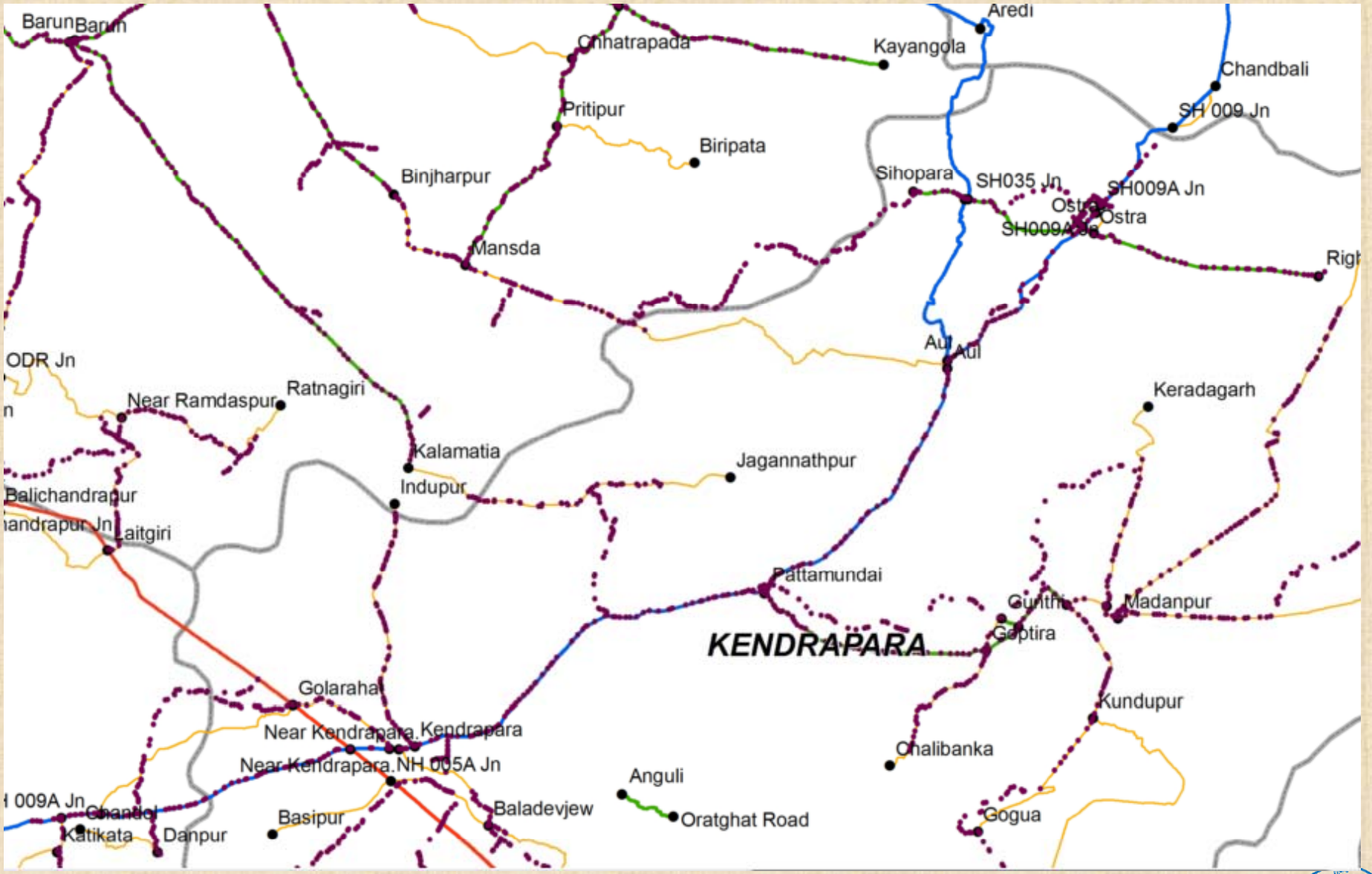
Road Name: KIRAI – BAMRA ROAD | Road No. : SH___, MDR 31, ODR___

Section name: MAJOR BUILDING | Chainage: Km 0/000 to Km 35/000 | Date of Survey : 03/09/2011

Division: SUNDARGARH | Surveyors : GAUTAM

Waypoint	Features: Km Stone	Features: Cross Road/Junction L	Features: Cross Road/Junction R	Features: Culvert	Features: Bridge Start	Features: Bridge End	Features: Bridge Center	Village Start	Village End	Inventory: Surface	Inventory: Width	ODOMETER READING	LAND USE	Remarks
113		✓	✓									22.93	A	Moorum/CC
114				✓								23.2	A	
115				✓								23.4	A	
116		✓								BT	SL	23.5	A	Moorum
117	✓											23.8	A	23rd km
118				✓								24.2	A	
119												24.13	A	Railway Crossing
120				✓				✓	✓			24.2	A	Dharuadihi village.
121			✓							DBT	SL	24.3	A	BT
122		✓	✓									24.5	BU	CC/CC
123												24.7	BU	R – Dharuadihi P.S.
124	✓											24.8	BU	24th km
125		✓										24.9	BU	Moorum
126				✓								25.1	BU	

GPS Referencing: Sample Map



Road Inventory

- R&B divisions to provide road inventory for each km of all roads
- Important features
  - Formation width and embankment height
  - Pavement type and width
  - Shoulder type and width
  - Name of the village & cross roads
  - Land-use
  - Terrain
- Verification done by GPS

Road Inventory Data Sheet

ROAD INVENTORY DATA															
Road Name **Banigocha Boarder Madhapur Khajuripada Phulbani Sarangada road** **Division:Phulbani**										**Road No.** *SH 1*					
Section **Phulbani (R&B) Section,South** **From** *142/800km* **To** *144/021km*										**Date of Survey** (dd/mm/yy) *16.08.11* **Engineer: A.K. Mishra**					
						CARRIAGEWAY		SHOULDER				CROSS ROAD			
From km	To km	Terrain Plain P Rolling R Hilly H Swamp S	Land Use Builtup Bu Agri A Forest F Ind I Res R Barren Ba Water W + L / R	Name of Village/ Town	Formation Width m	Type CC BT GR ER	Width m	Type CC BT GR ER	Width m	Embankment Height m	Submergence Y / N	Location + L / R / X km/m	Road No. / Name	Carriage Way Type & Width	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
142/800	143/100	P	Bu	Madhapur	12.00	BT	5.50	ER	2.65	0.6	N	143/075 L	Madhapur	CC 3.60	
143/100	143/550	R	F	Madhapur	11.00	BT	5.50	ER	2.15	1.0	N				
143/550	144/021	P	F	Madhapur	11.00	BT	5.50	ER	2.15	1.2	N				

Col. No	Explanation
1,2	Data for every 1 km, or less if significant change in column 3-12
3	Plain(P) or rolling (R) or hilly(H) or swamp(S)
4	Built Up (Bu) or agriculture (A) or forest area (F) or industrial (I) or residential (R) or barren land (Ba) or Water (W); state whether on the left (L) or the right side (R)
5	Name of each village separately, wherever present (**No grouping**), state the beginning and end wherever possible
6	The width of carriageway or pavements + shoulders
7	CC - Cement concrete, BT- Bituminous, GR- Gravel, ER - Earthen
8	Report in metres to one decimal place
9	CC - Cement concrete, BT-Bituminous, GR- Gravel, ER - Earthen
10	Report in metres to one decimal place. If both shoulders are of different width, record accordingly.If no shoulders available, report as Nil
11	Report in metres to a minimum of one decimal place. If less than a metre, to the nearest 5cm
12	submergence in Yes (Y) / No (N) [if yes, state the chainage from / to in remarks column]
13	Report the chainage km/m of the above road where it crosses another road; state whether on the left **(L)** or the right side **(R)** or crossing **(X)**
14	Name of the cross road and No. if available
15	Carriageway Type: CC - Cement concrete, BT-Bituminous, GR- Gravel, ER - Earthen & Width in (m)

Inventory Verification

- GPS instrument, jurisdiction map and inventory data provided to the survey team.
- Start and end points of roads identified.
- Locations of features recorded as waypoints in GPS instrument.
- Width of pavement and shoulders measured to the nearest 10 cm.
- Change in pavement or shoulder type, or land-use.

Pavement Composition

- R&B divisions to provide pavement composition of each road.
- Important features – type and thickness of:
  - Surface course
  - Binder course
  - Base course
  - Sub-base
  - Subgrade (Soil)

Pavement Composition Data Sheet

PAVEMENT COMPOSITION														
Road Name: Jaipur Kartikata Road			**Division :Jagatsingpur**						**Road No.** : *SH2*					
Section: Boudh R&B Section			From 0/0kmTo 1/723km						**Date of Survey** (dd/mm/yyyy) : *16.08.11*		**Engineer: B.K. Pati**			
Chainage		Pavement Composition										Shoulder Type	Right-of-Way (m)	Remarks
		Surface Course		Binder Course		Base Course		Subbase Course		Subgrade				
From km	To km	Type	Thickness (mm)	Type	Thickness (mm)	Type	Thickness (mm)	Type	Thickness (mm)	Type	Thickness (mm)			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0/0	1/000	SC	6	PMC	20	WBM	150	Moorum	225	Stabilised soil	500	Gr	25	
1/000	1/723	SC	6	PMC	20	WBM	150	Moorum	225	Stabilised soil	500	Gr	30	

Data Type	Col. No.	Sub Data Type	Explanation
Chainage	1,2		Mention chainage in km/m wherever there is any change of data in any of the columns 3 to 14.
Pavement type	3	Surface	Bituminous concrete- BC, Semi dense bituminous concrete- SDBC, Cement Concrete- CC, Premix carpet-PC, Built up spray grout- BUSG, Mix seal surfacing- MSS
	4,6,8,10	Thickness	Mention thickness of each layer in mm
	5	Binder	Bituminous macadam- BM, Dense bituminous macadam- DBM
	7	Base	Water bound macadam- WBM, Wet mix macadam- WMM
	9	Sub-base	Granular sub base- GSB, moorum, sandstone, quarry, stone soling
	11	Subgrade	Hard soil, soft soil, lime stablized soil, clay, any other
Shoulder type	13		Paved- P, Gravel- Gr, Earthen- E
Right of way	14		Right of way (Reserved width of land for roads) in m

Culvert Inventory

- R&B divisions to provide inventory of every culvert on the road.
- Important data collected
  - Location
  - Culvert type, length, thickness of slab
  - Span arrangement
  - Height above bed level
  - Scour
  - Adequacy of waterway
- Verification of location done by GPS

Culvert Inventory Data Sheet

INVENTORY SURVEY FOR CULVERTS										
Road Name: Ambiki-Bagadi Road			**Division:Angul**			**Road No.** : *SH 12_*				
Section: **Boudh R&B Section**			***From*** *0/152km* ***To*** *0/460km*			**Date of Survey** (dd/mm/yyyy) : 17.08.11		**Engineer:M.Sahoo**		
Sl. No.	Location (km/m)	Type of Structures (Pipe, Slab, Box, Arch)	Thickness of Slab (m)	Span Arrangement and Pipe Diameter (No.x Length) (m)	Carriageway Width (m)	Length of Culvert (m)	Height Above Bed Level D/S side (m)	Scour High-H, Medium-M, Low-L, Nil	Adequacy of Waterway (Yes / No)	Remarks
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	0/152	Pipe	_	2X 1.0 m	5.50	10.00	0.60	L	Yes	
2	0/460	Pipe		2X 1.0 m	5.50	10.00	0.75	L	Yes	

Column reference	Description
2	Report location in km/m
3	RCC slab, box, hume pipe, brick arch, stone
4	Thickness of Slab has to be given for stone slab, RCC slab
5	Span arrangement has to be mentioned. In case of hume pipe, internal diamter of the pipe has to be mentioned.
6	Record width of carriage way in metres to one decimal place
7	Record width of culvert in metres to one decimal place
8	Depth from the bed level (downstream side) to the soffit of the culvert (Soffit :- the highest internal level of pipe / slab)
9	H -high, M-medium, L- low, N-Nil
10	Yes or No

Inventory Verification

- GPS instrument, jurisdiction map and GPS data entry format, inventory data of the division with the survey team.
- Location of each culvert is recorded with the help of GPS.
- Chainage is verified from the data provided and waypoint updated.
- Information about the type of culvert is obtained by visual observation.
- In the case of slab culvert the thickness of slab, and in the case of pipe culverts the diameter of the pipes and number of rows.

Bridge Inventory

- R&B divisions to provide bridge inventory data
- Important data collected

  Chainage , structure no., river name, year of construction

  Type of bridge, skew angle

  Number of spans, clear span length, span arrangement

  Superstructure, bearing, footpath, railing, wearing coat

  Substructure, foundation, protection works

  Clear waterway, design HFL, vertical clearance, discharge & velocity

  Design live load

  Road formation level

- Verification of location done by GPS

Bridge Inventory Data Sheet

BRIDGE INVENTORY

Road Name :- Sohela-Nuapara Road **Division - Baragarh** **Road No. : - SH3**

Section: - **from 0/913Km** **Date of Survey- 17.08.11** **Egineer- K.Pati**

Sl. No.	Bridge no.	Location (km)	Name of river bridge	Year of construction	Numberof span	Span arrangements (no.x span length in m)	Clear span(m)	Length of bridge(m) (between inner face of dirt wall)	High level or submersible	Clear road way width between kerb (m)	Outer width of bridge (m)	Width of footpath(m)	Super structure: Type	Super structure: Type of bearing (Elastomeric/pot cum PTFE/roller-Rocker)	Super structure: Thickness of slab(m)	Super structure: Material of slab (RCC/PSC)	Super structure: Handrail/Parapet thickness & height (m)	Wearing coat: Type (CC / Flexible)	Wearing coat: Thickness(mm)	Substructure: Type: Abutment	Substructure: Type: Pier	Substructure: Type: Wing wall	Substructure: Thickness of pier: Top	Substructure: Thickness of pier: Bottom	Substructure: Height of pier & Abutment (m)	Substructure: Material: Abutment (Masonry/PCC/RCC)	Substructure: Material: Pier (Masonry/PCC/RCC)	Substructure: Material: Wing wall (Masonry/PCC/RCC)
1	2	3	4	5	6	7	8	9	10	11	12	13	15	16	17	18	19	20	21	22A	22B	22C	23	24	25	26	28	29
2	0/5	0/913	River Mahanadi	1992 - 1997	15	15 x 41.53	40.53	623	H.L.	7.5	8.35		Box girder RCC	Roller & Rocker	3.1	RCC	Th.-0.20 Ht.-1.10	CC	100	Solid wall	Solid wall	Splayed wall	1	1	5.59	RCC	RCC	RCC

Pier foundation: Type	Pier foundation: Materials	Abutment foundation: Type	Abutment foundation: Materials	Protection Work: Bed	Protection Work: Approach	Skew angle (degree)	Vertical clearance (m)	Road formation level	Direction of flow	clear waterway(m)	Design loading	High flood level (HFL)	Lowest water level	Degign dischage (cumecs)	Maximum design velocity (m/sec)	Remarks
30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Well foundation	RCC	Open foundation	RCC		Stone Rip rap			16.5	Perpendicular	608		11.2	7.14			

Right-of-Way Features Inventory

- R&B divisions to provide ROW features inventory data
- Data collection done using GPS survey
- Location of important features within ROW
  - Built-up area and their use
  - Drains, sewer line etc.
  - Pipelines (water / gas / OFC etc.)
  - Utilities (electric poles, telephone, street light etc.)
  - Traffic sign boards
  - Trees
  - Other utilities (bus shelter, gate, hand pump, well etc.)
- Verification of location done using GPS

R-O-W Features Inventory Data Sheet

Right-of-Way Features

Road Name : Baripada Road				Road No : SH MDR **14** ODR		
District : Panikoili				Date of Survey : 14.07.2011		
Section : From km_0.00__ to km__3.50__				Engineer : S.K. Kumar		
Chainage	Waypoint	Offset		Asset Code	Start (S) / End (E)	Remarks
		LHS	RHS			
1/100	181	6.5		BU1	S	
1/400	182	8.5		BU1	E	
2/540	183		7.5	P3		
2/850	184	6.5		S2		
3/500	185		5.95	BU3	S	

Detail Explanation of Assets

Features		Asset Code	Remark
Built Up	House	BU1	Built Up Structure with less than 10m front width will be captured as point feature and more than 10m will be captured as linear feature with Start/ End points
	Shop	BU2	
	Industry	BU3	
	Temple/Mosque/Church	BU4	
	Others	BU5	
Bus Shelter	Bus Bay	BB1	To be captured as point feature
	Bus Lay By	BB2	
Gate		G1	To be captured as point feature
Guard Post		GP	To be captured as point feature
Hand Pump		HP	To be captured as point feature
OFC		OFC	To be captured as linear feature
Pipes/ Cabies	Water	WP	To be captured as linear feature
	OFC	OFC	
	Gas	GAS	
Poles	Electric	P1	To be captured as point feature
	Telephone	P2	To be captured as point feature
	Street Lights	P3	To be captured as point feature
ROW Fence		RF	To be captured as linear feature
Road Side Drains		RSD	To be captured as linear feature
Sewer Line		SL	To be captured as linear feature
Signs	Information	S1	To be captured as point feature
	Mandatory	S2	To be captured as point feature
	Warning	S3	To be captured as point feature
	Other	S4	To be captured as point feature
Statue		ST	To be captured as point feature
Tree		TR	Trees with girth size more than 30cm to be captured as point feature
Well		W1	To be captured as point feature

Condition Survey

Pavement Condition

- Pavement condition survey is done as a measure of the ability of the pavement to continue to provide required service to the public
- Consists of three components
    1. Surface distresses
    2. Ride quality
    3. Structural strength
- Survey conducted on SHs and MDRs

Pavement Distresses

- Condition rating is carried out based on four distresses for each type of pavement based on three levels of **severity** and **extent**

Bituminous (BT) or Flexible Pavement	Cement Concrete (CC) or Rigid Pavement	Gravel (GR) or Water Bound Macadam (WBM) Pavement
Cracking	Cracking	Loose gravel
Potholes	Potholes	Potholes
Raveling	Joint deficiencies	Rutting
Rutting	Faulting or stepping	

Pavement Condition…Contd.

- **Severity**

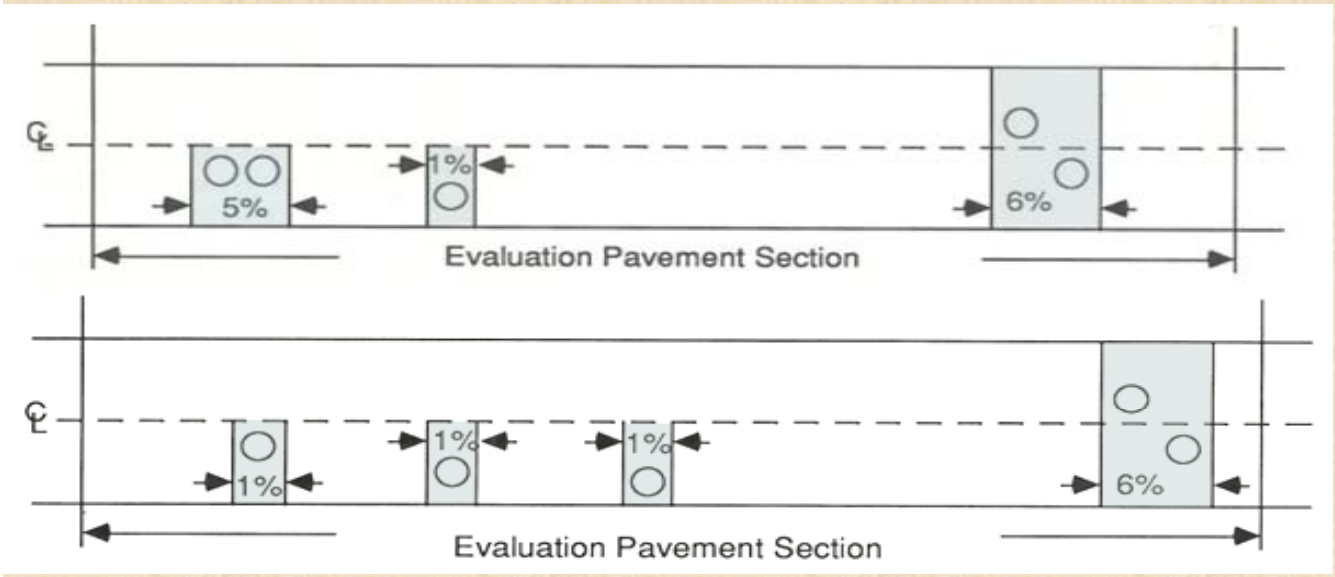
  'Severity' refers to how bad the problem is. The severity scale has three levels: *low, medium, and high*. Guidelines give a verbal description of each stage together with pictorial representations.

- **Extent**

  'Extent' refers to the size of the problem area. The extent scale has three levels*: intermittent, frequent and extensive*.

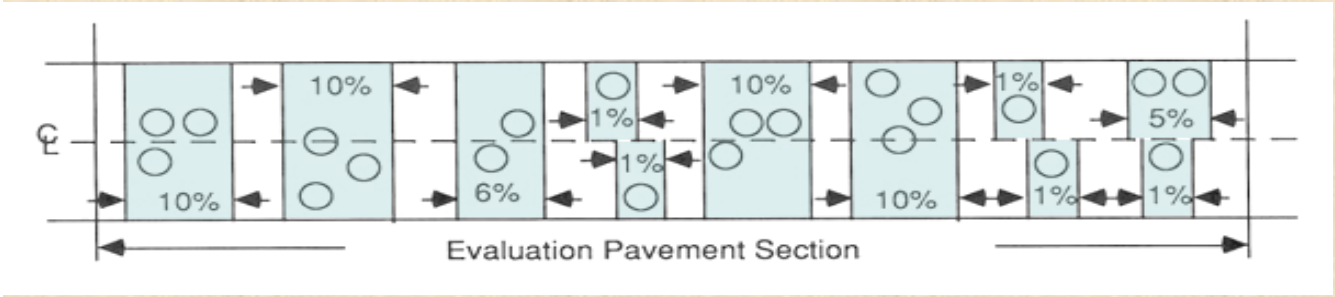
Class	Guidelines
Intermittent	Less than 20% of pavement surface affected. Spotted over localized areas only.
Frequent	20% to 50% of pavement surface affected. May be spotted evenly over length of pavement section or over localized areas only.
Extensive	More than 50% to 100% of pavement surface affected. Spotted evenly over length of pavement section.

Extent of Distress - Rating



Intermittent
(< 20%)

Frequent
(20-50%)



Extensive
(> 50%)

Pavement Distress Evaluation

- Drive slowly to visually inspect the surface
- Stop to examine the distresses in terms of type, severity, and extent
- For two-lane highways, average extent and severity in both lanes. On divided highways, evaluation done for each direction separately.

Flexible Pavement – Severity Rating

Distress	Low	Medium	High
Cracking	Crack **up to 10 mm in width**	Crack of **10-20 mm in width**	Crack **more than 20 mm in width**, or multiple cracks
Pothole	**100 mm or less in width** and up to 50 mm in depth	**100–300 mm** in width and more than 50 mm in depth	**More than 300 mm in width** and more than 100 mm in depth
Rutting	**Depth less than 15 mm**	**Depth 15–30 mm**	**Depth more than 30 mm**
Raveling	Noticeable loss of pavement material	Surface texture visibly appears as open, slightly disintegrated surface	Wide open texture with loose materials, slightly disintegrated surface with small potholes

CC Pavement – Severity Rating

Distress	Low	Medium	High
Cracking	Crack **less than 10 mm in width**	Crack of **10-20 mm in width**, or multiple cracks (even if crack width is less than 10mm)	Crack **more than 20 mm in width**, or multiple cracks with spalling (even if crack width less than 20 mm)
Pothole	Pothole resembles pop-out of coarse aggregate with or without disintegration of surrounding materials	Pothole more than pop-out of coarse aggregate but **less than 75 mm in width and depth**	**Width and depth 75 mm and over**, with or without interfering the rideability
Joint Deficiencies	Sealant broken and beginning to pull out; joint separation visible, **less than 15 mm**	Sealant broken and pulled out by up to **50%** of its length; joint separation **15–30 mm**	Sealant completely broken and pulled out **80% or more** of its length; joint separation **more than 30 mm** with or without breakdown of slabs adjacent to the joint
Faulting (Stepping)	**Less than 10 mm**	**10–20 mm**	**More than 20 mm**

GR-WBM Pavement – Severity Rating

Distress	Low	Medium	High
Loose Gravel	Loose aggregate on roadway **less than 50 mm in width**	Loose aggregate on roadway **50–200 mm in width**	Loose aggregate on roadway **more than 200 mm in width**
Pothole	**Less than 100 mm in width** and less than 50 mm in depth	**100–300 mm in width** and more than 50 mm in depth	**More than 300 mm in width** and more than 100 mm in depth
Rutting	**Less than 100 mm in depth**	**100–200 mm in depth**	**More than 200 mm in depth**

Flexible Pavement Distress Evaluation

- Pothole

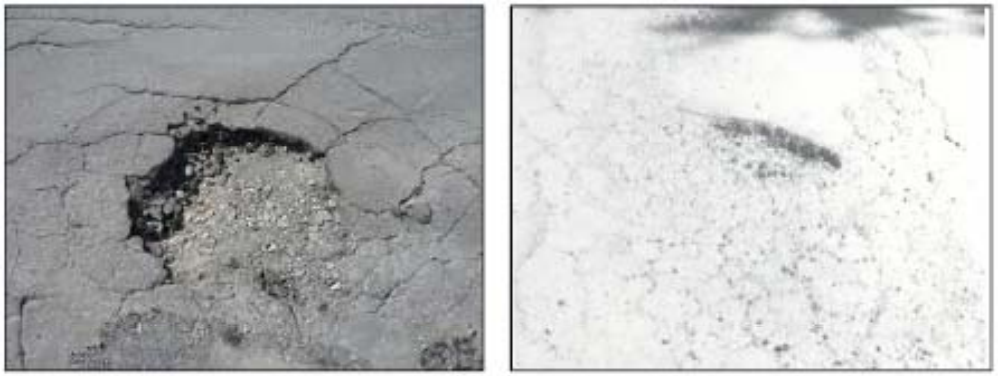
  Bowl, round or irregular shaped holes (depressions) in pavement. It can be unrelated or a direct result of other defects such as ravelling, alligator cracking etc.

- Severity

Level	Description
Low	100 mm or less in width and upto 50 mm in depth
Medium	100 mm – 300 mm in width and more than 50 mm in depth
High	Width is more than 300 mm and usually depth is more than 100 mm

Pothole – Severity Levels

Low Severity Pothole



Medium Severity Pothole

High Severity Pothole

Flexible Pavement Condition Evaluation Data Sheet

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM

Road Name Sohela Nuapada Road **Division** : Baragah **Road No** SH3

Section **From** : 0/000KmTo 5/000KM **Date of Survey(dd/mm/yy):**14.08.11 **Engineer**:B.N. Dutta

CHAINAGE		CRACKING						POTHOLES						RAVELLING						RUTTING						Remarks if any
		SEVERITY			EXTENT			SEVERITY			EXTENT			SEVERITY			EXTENT			SEVERITY			EXTENT			
From km	To km	Low	Medium	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Low	Medium	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Low	Medium	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Low	Medium	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	
0/000	1/000			Y	Y				Y		Y			Y					Y		Y		Y				
1/000	2/000	Y				Y		Y				Y				Y		Y		Y				Y		
2/000	2/850			Y	Y				Y		Y			Y					Y		Y		Y			
2/850	3/550	Y				Y		Y				Y				Y		Y		Y				Y		
3/550	5/000			Y	Y				Y		Y			Y					Y		Y		Y			

Rigid Pavement Condition Evaluation Sheet

CEMENT CONCRETE (RIGID) PAVEMENT CONDITION EVALUATION FORM

Road Name Defunct N.H. 23	**Division :** Angul	**Road No.** *ODR*
Section	**From** *0/000km* **To** *2/850km*	**Date of Survey** (dd/mm/yy) 11.08.11 **Engineer :** P.Mohanti

Chainage		CRACKING						POTHOLES						JOINT DEFICIENCY						FAULTING(STEPPING)						Remarks, if any
		SEVERITY			EXTENT			SEVERITY			EXTENT			SEVERITY			EXTENT			SEVERITY			EXTENT			
From Km	To Km	Low	Medium	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Low	Medium	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Low	Medium	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Low	Medium	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	
0/000	1/000			Y					Y		Y			Y					Y		Y			Y			
1/100	2/250	Y				Y		Y				Y				Y		Y		Y				Y			
2/250	2/850			Y					Y		Y			Y					Y		Y			Y			

Gravel Surface Pavement Condition Evaluation Sheet

GRAVEL PAVEMENT SURFACE CONDITION EVALUATION FORM

Road Name Kulad-Talcher Road **Division :** Angul **Road No.** *ODR*

Section : **From** 0/000*km* **To** *2/850km* **Date of Survey** (dd/mm/yy) *15.08.11* **Engineer :**B.K.Mallik

Chainage		LOOSE GRAVEL						POTHOLES						RUTTING						Remarks, if any
		SEVERITY			EXTENT			SEVERITY			EXTENT			SEVERITY			EXTENT			
From Km	To Km	Low	Medium	High	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Low	Medium	high	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Low	Medium	high	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	
0/000	1/000			Y					Y		Y			Y					Y	
1/000	2/085	Y				Y		Y				Y				Y		Y		
2/085	2/850			Y					Y		Y			Y					Y	

Pavement Roughness

- Pavement roughness is generally defined as an expression of irregularities in the pavement surface that adversely affect the riding quality of a vehicle and thus the user.

Pavement Roughness

- Roughness measured on SHs and MDRs using ROMDAS.
- The instrument measures the relative displacement of the vehicle body to the axle.
- Data reported in terms of IRI of the road section

Pavement Deflection

- Benkelman beam deflections every 500m on SHs and MDRs.

Traffic Survey

- At 200 locations on SHs, MDRs and selected ODRs
- 3-day vehicle counts classified into 15 vehicle types
- Helps to determine the capacity utilization and forecast
- Used in Traffic Information System (TIS) linked to RIS

Axle-Load Survey

- At 30 locations on SHs, MDRs and selected ODRs
- To be used in pavement design and strengthening.

Bridge Condition Survey

Bridge Condition Survey - Concepts

A. It is a misconception that a bridge once constructed does not require any substantial maintenance for the first couple of decades.

B. To maintain the serviceability of the bridges and to ensure a reliable level of service, due recognition by the maintenance authorities is essential.

C. Large number of bridges are on the verge of un-serviceability due to repeated heavier loading.

D. Even high quality of construction without proper maintenance, will lead to early failure of the bridge.

Bridge Condition Survey…Contd.

- The steps necessary for a reliable serviceability level of the bridge:

Activity	Achievement
Quality construction	Lesser cost of maintenance
Quality maintenance	Lesser cost of special repair
Quality special repair	Delayed strengthening and rehabilitation
Quality rehabilitation	Delayed reconstruction Least risk of serviceability loss Low cost of future maintenance Delayed future special repair Delayed future strengthening and rehabilitation

Bridge Condition Survey…Contd.

- Lack of regular maintenance leads to deterioration of the bridges.
- In the absence of regular maintenance normally ad-hoc decisions are taken at crisis for the maintenance, which is not only dangerous but also reduces the life of structure.
- For proper maintenance of bridges, regular inspection data is required.
- Maintenance grants for the bridges are not utilized properly on account of lack of inspection data for bridges

Bridge Condition Survey

- Bridge condition survey is required :

  to evaluate structural soundness

  to establish a database in the BIS

  to take timely action for maintenance to prevent further deterioration

Bridge Condition Survey

- Critical attributes of bridge condition survey

  I. Spalling
  II. Cracking
  III. Corrosion
  IV. Settlement / scour / deformity
  V. Condition of bearings

Bridge Condition Survey

- Elements for Evaluation
  I. Foundation and Protection Works
  II. Substructure
  III. Superstructure
  IV. Bearings

Bridge Condition Rating

Severity

Level	Description
Nil	No visible damage
Low	All elements are in good condition with minor deterioration
Medium	Element has only minor/advance section problems
High	Structural capacity of element is affected or jeopardized by advanced deterioration, section loss, spalling, cracking, or other deficiency

Extent

Level	Description
Nil	No distress visible
Few	Less than 10% surface area affected
Moderate	10 to 25% surface area affected
Extensive	More than 25% surface area affected

Methodology

Four-step process

- Identifying the distress types
- Visual observation of distress
- Condition rating for elements
- Overall rating of the bridge

Scour and Settlement

Severity

Sl. No.	Description	Rating
1	No Scour visible	No damage
2	Observed depth of scour at foundation location is normal	Low
3	Depth of scour is more and settlement is less	Medium
4	Depth of scour is more and critical. Settlement of sub structure is also more and there is vertical dislodgement of pier and abutment	High

Extent

Sl. No.	Description	Rating
1	No Scour, No Settlement	Nil
2	Up to 10% of foundations scoured	Few
3	10% to 25% of foundations scoured	Moderate
4	> 25% of foundations scoured	Extensive

Spalling of Concrete

Severity

Sl. No.	Description	Rating
1	No Spalling	Nil
2	Slight spalling. Depth of spalling less than 10mm. Reinforcement not exposed.	Low
3	Extensive spalling of depth < 50mm. Less exposure of reinforcement.	Medium
4	Extensive spalling. Depth > 50mm. Reinforcement exposed and corroded.	High

Extent

Sl. No.	Description	Rating
1	No Spalling	Nil
2	Up to 10% of surface area affected, mostly localized	Few
3	10% to 25% of surface area affected, mostly localized	Moderate
4	> 25% of surface area affected, either localized or evenly over length	Extensive

Cracking (Pattern, Width and Location)

Severity

Sl. No.	Description	Rating
1	No cracking	No damage
2	Hair Line cracks width <1.6mm	Slight
3	Narrow and medium Cracks width 1.6mm to 4.8mm	Moderate
4	Wide cracks width > 4.8 mm	High

Extent

Sl. No.	Description	Rating
1	No Cracks visible	No damage
2	Up to 10% of surface area affected, mostly localized	Low
3	10% - 25% of surface area affected, either localized or evenly over structure	Medium
4	More than 25% of the surface area affected, almost evenly over length	High

Corrosion

Severity

Severity of the Corrosion will be adjudged from the location of the corroded reinforcement, percentage of corrosion and pit corrosion.

Extent

Sl. No.	Description	Rating
1	No corrosion	Nil
2	Up to 10% of surface area affected, mostly localized	Low
3	10% - 25% of surface area affected, either localized or evenly over structure	Medium
4	More than 25% of the surface area affected, almost evenly over length	High

Bearings

Severity

Sl. No.	Description	Rating
1	No damage	Nil
2	Surface cracks in pedestal and slight deformation of bearings	Slight
3	Cracks having <1.6mm wide, and spalling in pedestal, appreciable deformation in bearings	Moderate
4	Slitting and wide cracks in pedestal, Bulging, deformation, bearing not sitting in full length, anchor bolts missing, rusting of bearings	High

Extent

Sl. No.	Description	Rating
1	No damage	Nil
2	Minor damages in Pedestal and Bearings	Low
3	In 10 to 25% of bearings, there are damages in Pedestal, but no damage observed in Bearings	Medium
4	More than 25% of the Pedestal and bearings are damaged	High

Bridge Condition Rating Summary - Extent

Distress	Nil	Few	Moderate	Extensive
Scour and settlement	No Scour visible	Up to 10% of foundations scoured	10% to 25% of foundations scoured	> 25% of foundations scoured
Spalling	No Spalling	Up to 10% of surface area affected, mostly localized	10% to 25% of surface area affected, mostly localized	More than 25% of surface area affected, either localized or evenly over length
Cracking	No cracking	Up to 10% of surface area affected, mostly localized	10% to 25% of surface area affected, either localized or evenly over structure	More than 25% of the surface area affected, almost evenly over length
Corrosion	No corrosion	Up to 10% of surface area affected, mostly localized	10% to 25% of surface area affected, either localized or evenly over structure	More than 25% of the surface area affected, almost evenly over length
Deformation of bearings	No damage	Minor damages in pedestal and bearings	In 10 to 25% of bearings, there are damages in pedestal, but no damage observed in bearings	More than 25% of the pedestal and bearings are damaged

Bridge Condition Rating Summary - Severity

Distress	Nil	Low	Medium	High
Scour and settlement	No Scour visible. No damage to protection works	Observed depth of scour at foundation location is normal. Less dislodgement of protection works.	Depth of scour is more and settlement is less. Bed protection works are dislodged.	Depth of scour is more and critical. Settlement of sub structure is also more and there is vertical dislodgement of pier and abutment.
Spalling	No Spalling	Slight spalling. Depth of spalling less than 10mm. Reinforcement not exposed.	Extensive spalling of depth < 50mm. Less exposure of reinforcement.	Extensive spalling. Depth > 50mm. Reinforcement exposed and corroded.
Cracking	No cracking	Hair line cracks width <1.6mm	Narrow and medium cracks width 1.6mm to 4.8mm	Wide cracks width > 4.8 mm
Corrosion	Severity of the Corrosion will be adjudged from the location of the corroded reinforcement, percentage of corrosion and pit corrosion.			
Deformation of bearings	No damage	Surface cracks in pedestal and slight deformation of bearings	Cracks having <1.6mm wide, and spalling in pedestal, appreciable deformation in bearings	Slitting and wide cracks in pedestal, Bulging, deformation, bearing not sitting in full length, anchor bolts missing., rusting of bearings

Bridge Condition – Overall Rating

Sl No	Condition of Damages (Extent and Severity)					Overall Rating
	Scour / Settlements in Foundation/Protection Works	Spalling	Cracking	Corrosion	Deformity of Bearings	
1	No settlement / less scour	Slight or no spalling	No cracking/ hairline cracking	No corrosion	No deformity	Good Condition
2	No settlement. Normal scour	Both extent and severity are moderate	Both extent and severity are moderate. cracks are narrow	Slight corrosion	No deformity	Fair Condition
3	No settlement. Normal scour	Extensive and deep spalling	Extensive and medium cracks	Moderate corrosion	Damages of pedestal observed. Slight deformation of bearings	Poor Condition
4	Settlement of substructure. Scours in foundation and protection works	Extensive and deep spalling	Extensive and wide cracks	Heavy corrosion	Bearings out of sitting. Pedestal damaged	Severe Condition

Bridges: Action Needed

GOOD CONDITION

Minor repair may be done on short-term basis

FAIR CONDITION

All primary structural elements are in good condition but have minor section losses.

Immediate repairs are required.

POOR CONDITION

Losses of section, deterioration, spalling, cracking or scour have seriously affected primary structural components.

Local failures are possible. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.

SEVERE CONDITION

Major deterioration or section loss present in critical structural components.

Bridge has to be closed to traffic, requires rehabilitation or reconstruction.

Bridge Condition Data Sheet

BRIDGE CONDITION DATA

Road Name : **Road No. :** SH ____ MDR _____, ODR____ **Division :**

Bridge No.: **Bridge Location :** **Date of Survey :**

Damages		Spalling								Cracking								Corrosion								Settlement/Scour/Deformity							
		SEVERITY				EXTENT				SEVERITY				EXTENT				SEVERITY				EXTENT				SEVERITY				EXTENT			
Sl. No.	Bridge Element	Nil	Low	Medium	High	Nil	Few	Moderate	Extensive	Nil	Low	Medium	High	Nil	Few	Moderate	Extensive	Nil	Low	Medium	High	Nil	Few	Moderate	Extensive	Nil	Low	Medium	High	Nil	Few	Moderate	Extensive
1	Foundation																																
2	Protective Works																																
3	Substructure (Abutments/Piers)																																
4	Substructre Wing Walls/ Return walls																																
5	Superstructure Girder/ T Beams/ BoxGirder																																
6	Super structure Deck Slab/ Masonry Arch																																
7	Bearings																																
8	Additional Comments																																

Overall Condition Rating	Good	Moderate	Poor	Severe

Consultancy Services for

Orissa Asset Management System (O-AMS)

Workshop on

Needs Analysis and System Architecture

Works Department

Government of Orissa

Consultant

LEA Associates South Asia Pvt. Ltd.
(LASA), India
in joint venture with
LEA International Ltd. (LEA), Canada
in association with
Geo InfoSpace Private Ltd. (GIPL), India

AMS is a Planning Tool

Deals with planning of :

- Maintenance, rehabilitation & improvement of road assets in the most cost effective manner

What do we need for planning :

- What is the condition now ?
- What may happen in the future ?
- What needs to be done and when ?
- How much it will cost ?
- What will be the improvement / result ?
- What are the alternatives and their impact ?

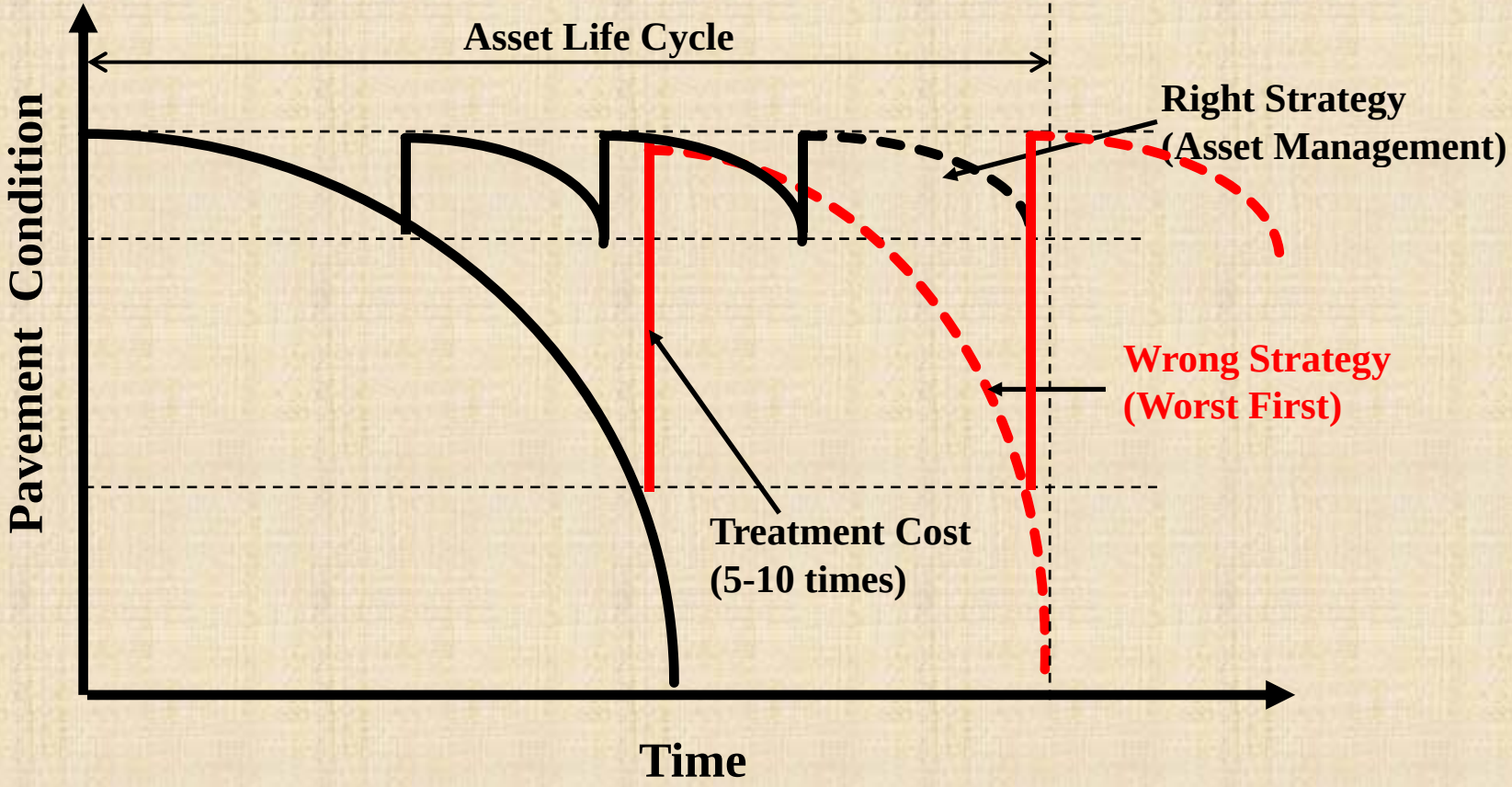
Uses of AMS

- Determine the health of the network
- Establish the needs
- Answer **‘what if’** in terms of budget levels, treatment choices or external factors

Process

- Inventory data
- Present condition assessment
- Target
- Performance prediction
- Techno-economic analysis
- Plan (short- & long-term)

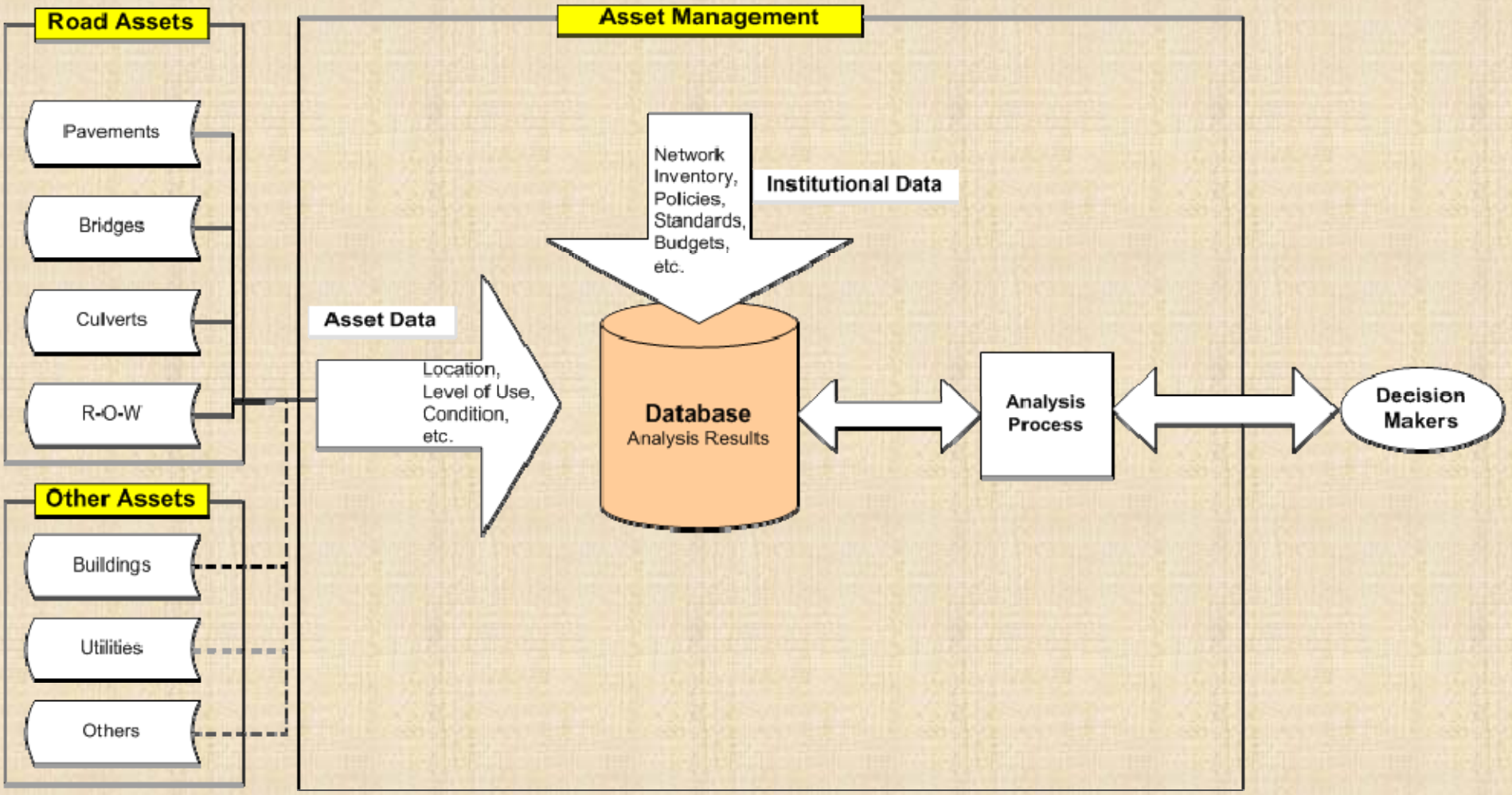
Pavement Performance



Elements of AMS – Steps Necessary

1.	Network definition	location
2.	Database	inventory, construction, maintenance, cost data
3.	Condition evaluation	data collection
4.	Maintenance & rehabilitation strategies	policies, standards and target
5.	Prioritization	ranking
6.	Optimization	maximise effectiveness
7.	Plans	short-term and long-term

Asset Management System



O-RAMS SYSTEM COMPONENTS

- Geographic Information System (GIS)
- Road Information System (RIS)
- Bridge Information System (BIS)
- Right-of-Way Features Information Management System (RWFIMS)
- Pavement Management System (PMS)
- Routine Maintenance Management System (RMMS)
- Traffic Information System (TIS)

Needs Analysis

Purpose of Needs Analysis

To Review

- OWD institutional set-up
- Maintenance management practices
- IT set-up

To Recommend

- Overall O-RAMS system architecture

To Evaluate and Inform

- Software to be developed / configured for O-RAMS
- Road information / management systems working in India and outside
- Confirm the software and hardware needed

We Have Reviewed

- OWD institutional set-up
- Functions and responsibilities of each wing / office
- Planning process
  - Plan and Non-Plan works
  - Special studies and design activities
  - Estimating and costing
  - Approvals
- Procurement of construction services
  - Registration of contractors
  - Procurement of works
  - Forms of agreement
  - Work execution and supervision
- Annual Budget

Planning Process

Concerns **Findings**

- Strategic planning activity in the Department - Lacking
- Tools for road planning / network improvement - Lacking
- Data collection and processing capabilities- Limited

Recommendations

- Prepare strategic plans, policies and master plan for the state road network based on sound engineering principles
- Re-classify the state road network
- Redefine Core Road Network (CRN)
- Develop prioritization criteria for road works
- Standardize procedures for maintenance of re-classified network

Road Maintenance

Concerns

- Non-plan budget not need-based and inadequate
- Lack of measured physical condition of roads
- Lack of attention to shoulder grading, drainage, etc.
- Pipes and culverts blocked

Recommendations

- Adopt a systematic approach to informed decision making
- Use techno-economic criteria
- Allocate resources where most effective
- Develop policies and standards
- Measure the effectiveness of programs
- Establish a Road Maintenance Management System

Data / Information Systems

Concerns

- Insufficient, irregular data, not accessible to all
- Lack of centralized data depository and processing
- Lack of skills to process the data for planning, design, construction and maintenance

Recommendations

- Collect traffic data including classified and origin-destination
- Collect riding quality and distress survey data
- Collect road accident data from secondary sources, e.g. police
- Establish a centralized GIS-based database containing all inventory, condition, traffic and maintenance history data

Review of IT Infrastructure

IT Policy

- OWD does not have any IT Policy

Software

- Limited use of software, only word processing / spread sheet / CAD

Hardware

- HQ 30 Pentium IV computers
- Division 2-3 computers each
- No database, email / exchange server

Communication

- HQ High-speed LAN with broadband internet connection
- Division Broadband / dialup connection
- Information dissemination to public through Department and OSRP website

Overall Assessment of IT Infrastructure

Level	Description
A	little IT infrastructure, no communications network, little ability to plan and manage IT, Infrastructure and organizational assistance required.
B	some IT infrastructure & limited LAN, little organizational capacity to plan and manage IT, Infrastructure and organizational assistance required.
C	**significant IT infrastructure including LANs,** **has multiple users in Central Office that would benefit from AMS,** **IT organizational assistance may be necessary for policies and procedures.**
D	significant IT infrastructure including LANs and WAN, strong policies and procedures, has multiple users in many locations and job functions
E	significant IT infrastructure, including WAN, strong policies and procedures, multiple applications that need to be integrated to AMS

Source: "Generic Terms of Reference for Supply and Installation of Road Management Systems" Version 1.0 – 31 January, 2007. East Asia Pacific Transport Unit, The World Bank, Washington, D.C.

Features in Asset Management Systems

AMS Level	Description
A & B	Typically limited to 1-4 concurrent users, stand-alone relational database (not a spreadsheet), minimum function to store, retrieve and apply data.
B & C	**Typically 5 – 25 concurrent users** **Has all basic functions required of an effective AMS, but lacks some of the advanced features**
D	Typically over 25 concurrent users Has all advanced functionality including features such as web-mapping Multi-user system with scalable enterprise level database
E	Advanced system with ability to access program features through custom developed software. Enables other applications to read RMS data, to store data, or external references to that data in the RMS

System Architecture

O-RAMS SYSTEM ARCHITECTURE

Encompasses:

- Conceptual model
- System components
- Functions of system components
- Relationships between the components
- Plan for procurement / development

O-RAMS SYSTEM COMPONENTS

- Geographic Information System (GIS)
- Road Information System (RIS)
- Bridge Information System (BIS)
- Right-of-Way Features Information Management System (RWFIMS)
- Pavement Management System (PMS)
- Routine Maintenance Management System (RMMS)
- Traffic Information System (TIS)

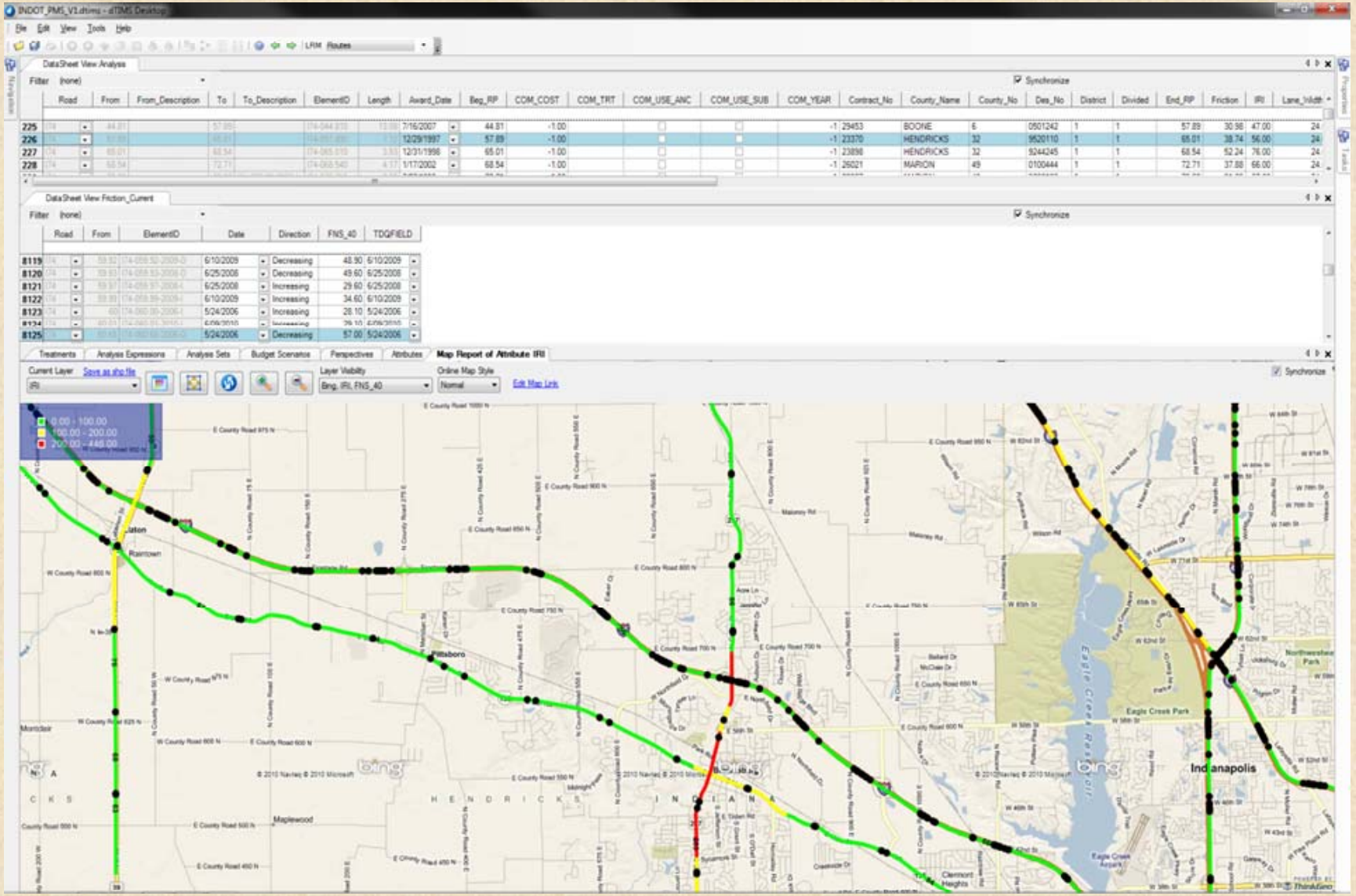
Geographic Information System (GIS)

- GIS is a powerful presentation tool to display on a map data e.g.
  - point features such as bridge, culvert, km stone
  - segment / line features such as the pavement
- GIS will be linked to RIS / BIS / RWFIMS
- Two most popular GIS Technology are ESRI and MapInfo
- Major off-the-shelf AMS software support files from ESRI
- Also used by ORSAC and other departments for map preparation

Recommendation:

ESRI : ArcGIS - ArcInfo

Geographic Information System (GIS)



Road Information System (RIS)

- It forms the basic framework of the O-RAMS, and will contain:
  - Location of roads and assets
  - Inventory information
- The location will be defined using a linear reference system similar to the system used in OWD
- RIS will have data management functions like input / import, view, modify, export generation of charts
- This will be linked to GIS for display of maps

Bridge Information System (BIS)

- It will contain inventory and the condition data on 1650 bridges
- Linear reference system in RIS will be followed in BIS
- It will have data management functions like input / import, view, modify, export generation of charts
- This will be linked to GIS for display of maps

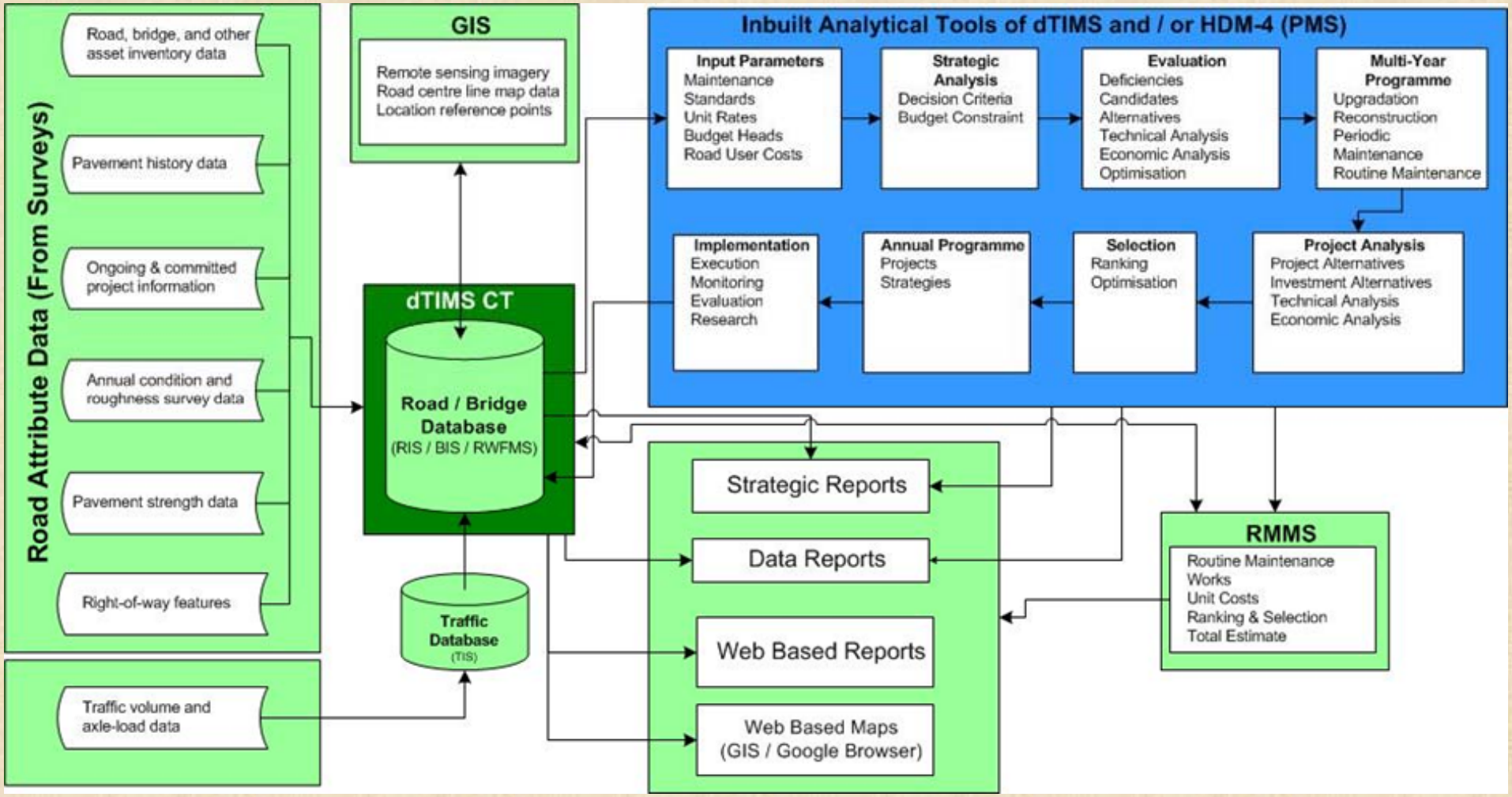
Right-of-Way Features Information Management System (RWFIMS)

- It will contain right-of-way features, e.g.,
  - Traffic signs, poles, trees, ditches / drainage channel
  - Guard posts, fencing, buildings, land details
- Linear reference system in RIS will be followed in RWFIMS
- It will have data management functions like input / import, view, modify, export generation of charts
- This will be linked to GIS for display of maps

Pavement Management System (PMS)

- Planning tool to predict periodic maintenance and rehabilitation requirements
- Used to prepare a multi-year maintenance plan optimized for the budget
- Analysis is based on techno-economic analysis
- PMS process
  - Inventory data
  - Present condition assessment
  - Target
  - Performance prediction
  - Techno-economic analysis
  - Plan (short- & long-term)
- Functions like data input / import, view, modify, export generation of charts / reports

PMS Flow Chart



Routine Maintenance Management System (RMMS)

- Planning tool to assign routine maintenance alternative
- Rule-based prioritization criteria for pavement and off-pavement activities
- RMMS process
  - Inventory data
  - Present condition assessment
  - Estimated costs
  - Plan
- Functions like data input / import, view, modify, export generation of charts / reports

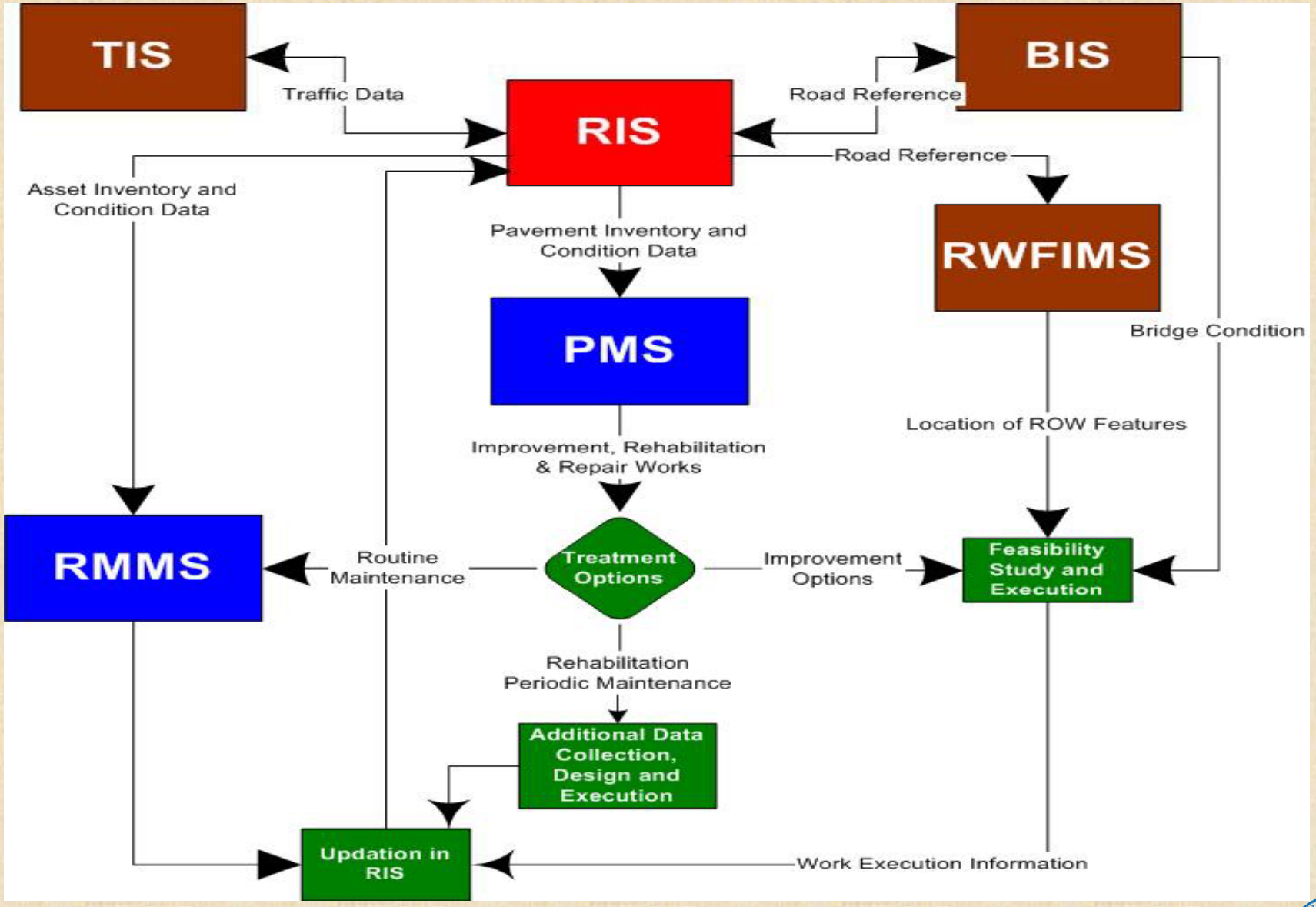
Traffic Information System (TIS)

- Planning tool to input, manage and forecast traffic data

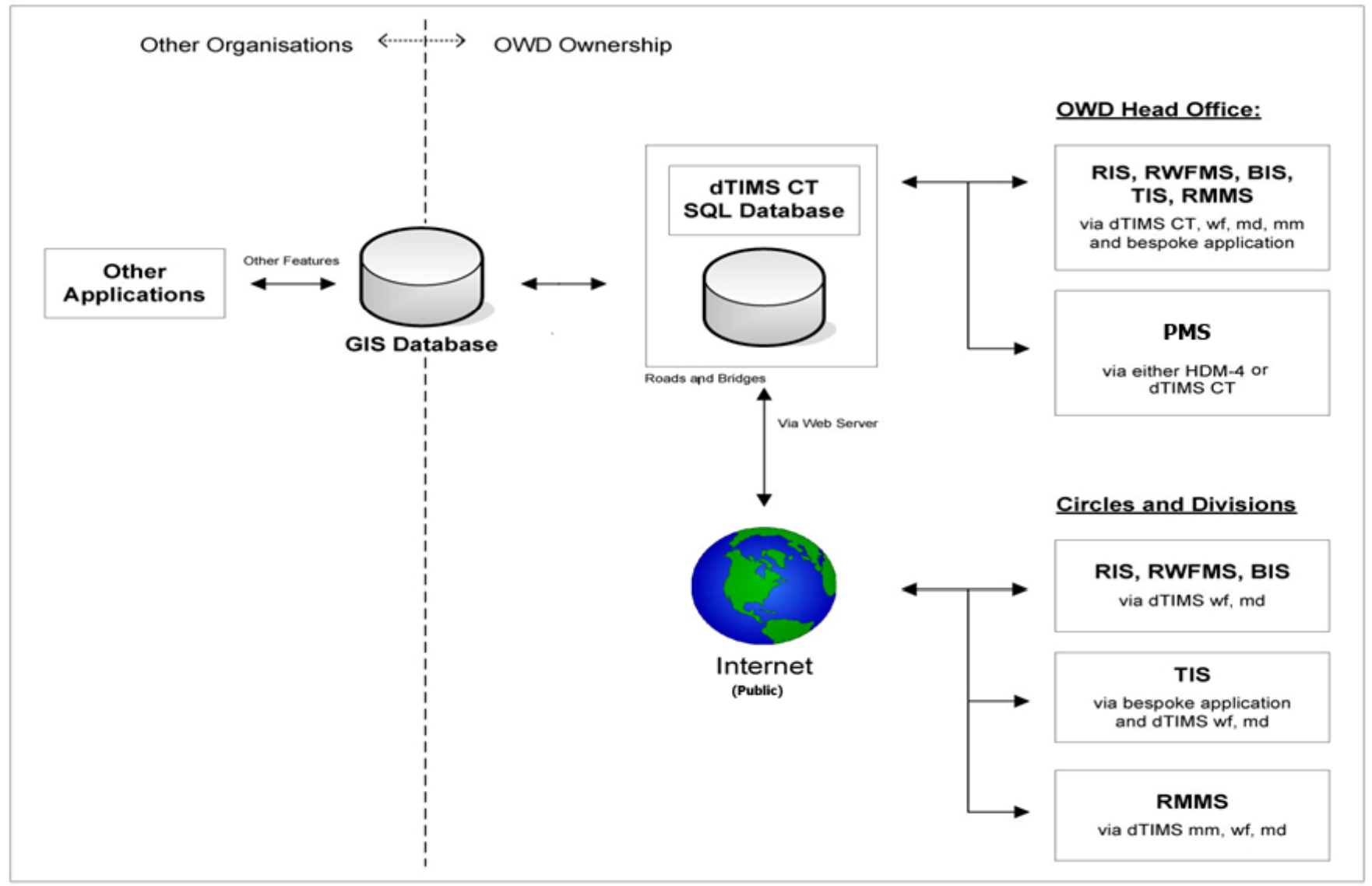
- TIS process
  - Create traffic count stations (from RIS)
  - Input raw data using import feature
  - Validate data using defined rules
  - Calculate AADT
  - Assign volume on roads
  - Create axle-load spectrum from axle-load survey
  - Forecast traffic volume and ESAL

- Functions like data input / import, view, modify, export generation of charts / reports

O-RAMS Component Relationship



O-RAMS System Architecture



Road Management Systems Implemented Elsewhere

State / Authority	Name of Existing System	Brief Details
National Highways Authority of India	Road Information System (RIS)	• Web / GIS based view of road information • 11 modules • HDM-4 based PMS • Oracle database
Roads and Buildings Department, Government of Gujarat	Gujarat Road Management System (GRMS)	• Not web based • 9 modules • 'Client-Server' and 'Desktop' versions • GIS enabled (view only) • Simplified and HDM-4 based PMS • SQL server database
Tamil Nadu Road Sector Project (TNRSP), Tamil Nadu State Highway Department	Road Management System	• Not GIS based. • Web based application has RIS, TIS, BIS • Desktop HDM-4 based PMS • RDBMS database
Public Works Department, Government of Karnataka	Road Information System (RIS)	• Web / GIS enabled • Oracle database
Ministry of Transportation, Ontario, Canada	Pavement Management System	• One of the earliest Pavement Management System in the world since 1982.

O-RAMS Software

O-RAMS

An asset management system (AMS) for roads must include

- Asset inventory - including location referencing
- Asset condition data
- Maintenance strategies
- Deterioration, remaining life and road-user cost models
- Prediction models – future condition, traffic forecast and growth rate etc.
- Life-cycle cost analysis
- Decision and tools – multi-criteria analysis, prioritizing and optimizing, trade-off analysis, risk analysis etc.
- Strategy – heritage management, accounting principles, asset valuation and capitalization of road infrastructure, policies.

O-RAMS Software

There are two possible ways to put an AMS in place:

1.Develop a system from scratch/modify an existing one, or

2.Acquire a ready-made commercial-off-the-shelf (COTS) software

O-RAMS Software – Development from Scratch

- Necessary team requirement (full time – in-house or external)

  Pavement Engineers, Bridge Engineers, Planning Engineers

  Maintenance/Construction and Operations Engineers

  Database Experts, Software Design Engineers, Modelling Experts

  Accounting and Costing Experts, Strategy and Policy Experts

- Developing a new asset management system is a complex and expensive undertaking and requires a high level of expertise and time
- Expertise not available locally
- Developing an AMS from ground-up is neither practicable, nor advisable
- Experiences of Gujarat & Ontario confirm the complexity of the task

O-RAMS Software – Commercial off-the-Shelf Software

In view of the time-frame available and the costs involved, the best course of action for a successful implementation of the system is to acquire a commercially available-off-the-shelf software.

Commercial off-the-Shelf Software Providers

- Confirm Pavement Manager, MapInfo Corp, USA
- dTIMS, Deighton Associates Ltd, Canada
- EXOR, Bentley Systems, UK
- ICON, GoodPoint Technologies, USA
- HIMS, HIMS Ltd, New Zealand
- Symology, Symology Ltd, UK

Criteria for Evaluation

As per functional and technical requirement of the software - Annexure 1 of Appendix A : Description of Services

- Widely used & high level of credibility / acceptability (No. of installations)
- Comprehensive, to include modules other than roads
- Web-based / ability to support multiple users
- Has all 5 modules
- GIS interface / link (To RIS, BIS and RWFIMS)
- HDM-4 interface / link (To PMS)
- Alternate models (better confidence in results)
- Support field data collection devices
- Purchase and maintenance cost

Evaluation of COTS Software

Feature	CONFIRM	dTIMS	EXOR	HIMS	ICON	SYMOLOGY
No. of installations	25+	180+	100+[1]	10+	N/A (but small)	25+
Web-based / Support multiple users	N/A	Yes	Yes	No[2]	Yes	Yes
Has all 5 modules	Yes	Yes	Yes	No[3]	Yes	Yes
GIS interface / link	Yes	Yes	Yes	Yes	Yes	Yes
HDM-4 interface / link	Yes	Yes	Yes	Yes	Yes	N/A
Alternate models	Yes	Yes	Yes	No	Yes	Yes
Support field data collection devices	Yes	Yes	Yes	Yes	Yes	Yes
Approximate cost		$978,600 \ $583,600[4]	$1,200,000			
Approximate maintenance cost		$ 68,900 \ $ 41,100[4]	$ 270,000			

1. Most EXOR installations are in the UK.
2. HIMS had no web-based version available. It is in the process of developing one.
3. HIMS's application is limited to road and bridge inventory, and road maintenance and planning using HDM-4. There is no right-of-way information system
4. Recommended configuration

COTS Software Evaluation Results

- dTIMS and EXOR are the only world-class software meeting all requirements for the proposed system.
- All others have a small footprint and are more local in nature.
- CONFIRM, ICON and SYMOLOGY have no facility to provide post-implementation support in India.
- SYMOLOGY does not appear to have any link to HDM-4.
- HIMS is:

  Not web-based

  No Right-of-Way Features Information Management System (RWFIMS)

- dTIMS and EXOR include HDM-4 deterioration models and analytical tools as well as their own experience-based models and tools as an alternative

Selection of COTS Software

- Significant difference in the in-built models in dTIMS and EXOR. While dTIMS is amenable to modifications, EXOR is relatively rigid or ‘black box’.
- For a similar configuration the initial cost of EXOR is about 25% more than that of dTIMS
- Maintenance costs of EXOR are 22% of the original licensing fee, dTIMS charges only 6%
- dTIMS has more world-wide installations, a longer proven record of more than 25 years
- dTIMS is being implemented at World Bank projects:
    1. Lesotho Ministry of Works
    2. Uganda National Road Authority
    3. Ethiopia Road Authority
- ADB procured dTIMS for Mongolia’s RMS now in progress

O-RAMS Implementation

O-AMS System Implementation

COTS Software	Function	Where Used
dTIMS CT ***(Core)***	Data repository and full-featured data management and analysis tool.	Head Office
dTIMS md ***(Management Dashboard)***	Browser-based tool for presenting results of analysis from dTIMS CT.	Head Office, Circles, Divisions
dTIMS wf ***(Work Flow)***	Browser-based tool for browsing/ importing data, executing queries, data transformation, etc.	Head Office, Divisions
dTIMS mm ***(Maintenance Management)***	Browser-based tool for planning, budgeting and management of day-to-day roadway maintenance operations.	

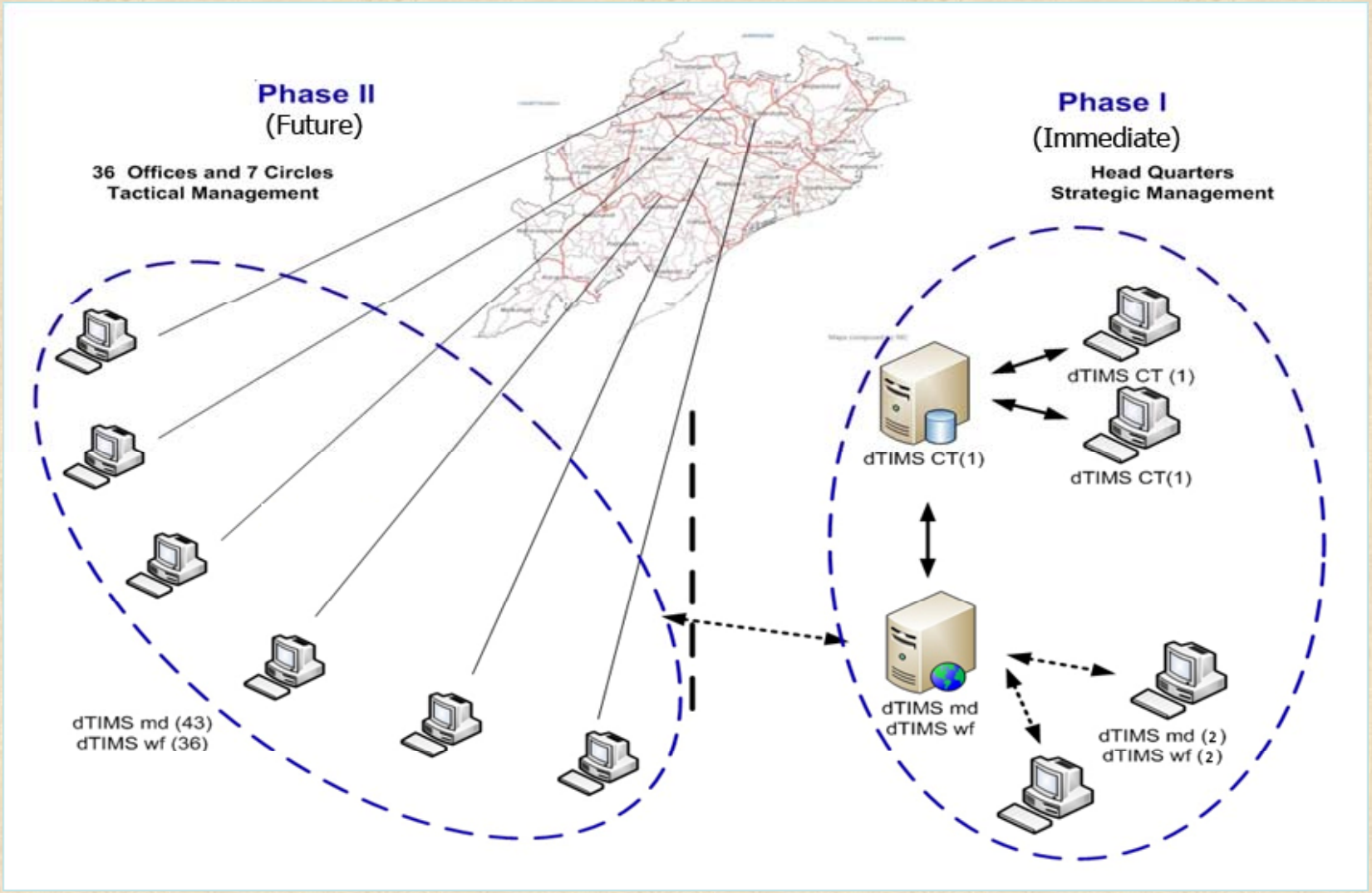
COTS Software Implementation Phases

The licenses for the COTS software should be implemented in two stages, as a prudent fiscal approach.

- Phase – I (Immediate): Few user licenses for each type of dTIMS software (CT / md / wf) need to be required for systems development and testing at the head office

- Phase – II (future): roll-out to all circles and divisions will require more licenses for dTIMS software (md / wf)

Software Implementation Phases



COTS Software Licensing Options

Immediate

COTS Software	HQ	Circles	Division	Total
dTIMS CT	3			3
dTIMS md	2			2
dTIMS wf	2			2

Future

COTS Software	HQ	Circles	Division	Total
dTIMS CT				
dTIMS md		7	36	43
dTIMS wf			36	36

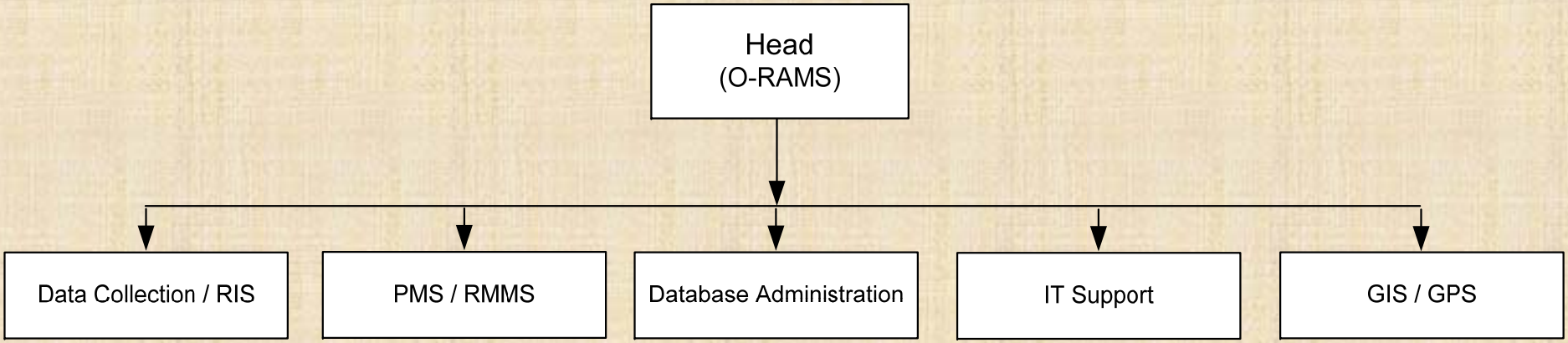
Other Software , Hardware, Networking Requirements

- ArcGIS (ArcInfo) - One
- Microsoft SQL Server 2008 – Enterprise Edition–One
- Internet Information Services (IIS 7.0 – For Web Server)–One
- Office Productivity Tools (Microsoft Office 2010– Home & Business Edn.)
- AntiVirus Software

- Server Computer (Xeon 2 Processor 2.4 GHz 48 GB RAM)–Two
- Microsoft Windows Server 2008 (Operating System)–Two
- Client computers (Windows 7 OS, Office Productivity Tools)
- Windows 7 – Professional Edition (Client Operating System)

- Printers and plotters
- OSWAN and 100 mbps LAN connectivity

O-RAMS Support Team



Asset Management

It is just what we are supposed to do