Pilot Project on Development and Implementation of Industry 4.0 Protocols for Rail-Coach Design & Manufacturing at Modern Coach Factory, Raebareli

under

Technology Mission for Indian Railways (TMIR)

- jointly by –

Ministry of Railways

Ministry of Science & Technology, DST

Ministry of Human Resource Development

Modern Coach Factory, Raebareli

Indian Institute of Technology Kanpur

September 27, 2019

Introduction

- The Modern Coach Factory (MCF) increased production from about 500 coaches per year by 3–4 times within a year and this was also enabled significantly by the adoption of Industry 4.0.
- Our Hon'ble Prime Minister's inspection of MCF in December 2018 is an inspiration to proliferate this initiative.
- This project envisages further implementation in MCF (enabling increase to 5000 coaches i.e. 10 times with Industry 4.0) and proliferation in railway units across India.
- This will also be useful in other Government Units such as Defense Production and in the private sector.

Objective	to develop and implement Industry 4.0 protocols for rail coach design and manufacturing processes for improved productivity and process flexibilities.
Cost	DST Share: 1663.84 Lakhs Railway Share: Rs. 4229.50 Lakhs.
Duration	24 months (From October 01, 2019)

before Industry 4.0

Industry 1.0 refers to the **first industrial revolution** (1760 – 1840)

- transition from hand production to machines through the use of steam power and water power
- had consequences on textile manufacturing, which was first to adopt such changes, as well as iron industry, agriculture, and mining

Industry 2.0 refers to the **second industrial revolution (**1870 and 1914)

- extensive railroad networks and the telegraph which allowed for faster transfer of people and ideas
- ever more present electricity which allowed for factory electrification and the modern production line

Industry 3.0 refers to the **third industrial revolution** (late 20th century)

- also called digital revolution
- from the production of Z1 (electrically driven mechanical calculator) to the development of communication technologies with the supercomputer.

Industry 4.0

Industry 4.0 is projected as the **fourth industrial revolution** (Hannover Messe, 2011)

- promotes computerisation of manufacturing
  - strong customization of products under the conditions of highly flexible (mass) production
  - introduction of methods of self-optimization, self-configuration, self-diagnosis, cognition and intelligent support of workers in their increasingly complex work

Four Design Principles in Industry 4.0

Interconnection: The ability of machines, devices, sensors, and people to connect and communicate with each other via the Internet of Things (IoT) or the Internet of People (IoP)

Information transparency: provides operators with vast amounts of useful information needed to make appropriate decisions.

Technical assistance: assistance systems by aggregating and visualizing information comprehensively for making informed decisions and to physically support humans by conducting unpleasant, exhausting and unsafe tasks for human workers.

Decentralized decisions: ability of cyber physical systems to make decisions on their own and to perform their tasks as autonomously as possible

National Policy for Advanced Manufacturing (NPAM)

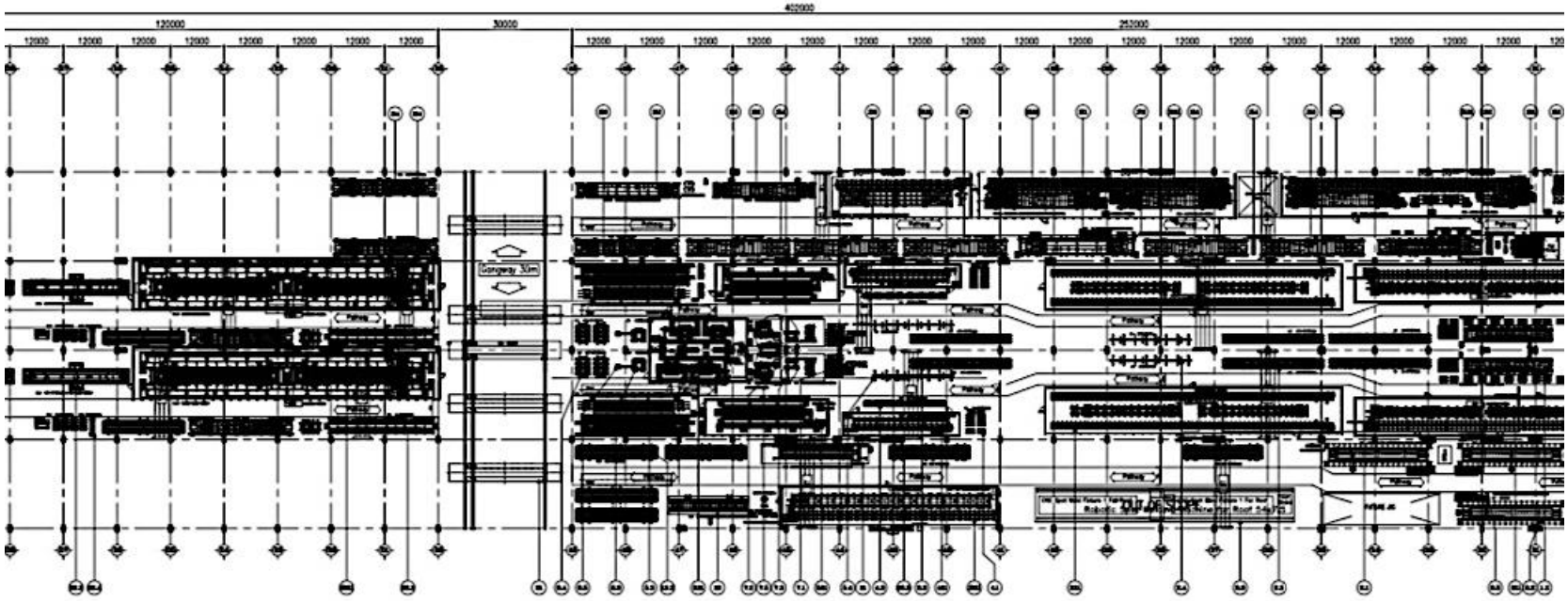
- envisages that manufacturing should constitute at least 25% of GDP.
- this initiative of the Technology Mission for the Indian Railways will help enable exponential increase in manufacturing in India with minimal expenditure.

Technology Domains

- Cyber-Physical Architecture of Industry 4.0 is complex
- architecture is of vital importance for it to get kick started initially and expanded gradually in a phased manner the architecture as conceptualized and formulated in MCF should be replicable
- Inter-disciplinary technology includes –
  - Internet of Things, Cloud Computing and Cognitive Computing
  - Component and System Design & Dynamics
  - Manufacturing Processes
  - Quality Control
  - Sensors
  - Data Acquisition
  - Signal Processing
  - Neural Networks, Multi-Objective Optimisatiopn, Fuzzy Logic
  - Reliability, Availability, Maintainability, Sustainability (RAMS)

Pilot Shopfloor

Shell Shop Layout



SIDE SUB ASSEMBLY LINE

1.1 IN-PUT STORAGE
1.2 SIDE SHELL SKELETON TACK WELDING STATION
1.4 HANDLING TOOL

2.1 IN-PUT STORAGE
2.2.1 SIDE SHELL SKELETON ROBOTIC WELDING STATION
2.3 OUT-PUT STORAGE
2.4 HANDLING TOOL

3.2.1 ROBOTIC SPOT WELDING STATION
3.3 OUT-PUT STORAGE

4.1 IN-PUT STORAGE
4.2.1 BEARER ROBOTIC ARC SPOT WELDING STATION
4.3 OUT-PUT STORAGE

5.2.1 SIDE SHELL & BEARER WELDING STATION
5.3 LEFT OVER WELDING STATION
& BACK PIECE WORK STATION WITH LOCATING TOOL
& OUT-PUT STORAGE
5.4 HANDLING TOOL

END SHELL SUB ASSEMBLY LINE

7.1 IN-PUT STORAGE
7.2 END SHELL TACK WELDING STATION
7.3 END SHELL RE-WELDING STATION
7.5 SEMI-AUTO JIB BOOM CRANE

8.2.1 END SHELL ROBOTIC WELDING STATION
8.3 OVERWELDING STATION
8.4 OUT-PUT STORAGE
8.5 JIB BOOM CRANE

ROOF SUB ASSEMBLY LINE

9.1 IN-PUT STORAGE
9.2 ROOF SKELETON & SHEET MANUAL WELDING STATION
9.4 HANDLING TOOL
9.5 JIB BOOM
9.6 ROOF ROBOTIC SPOT WELDING STATION("OUT OF SCOPE")

10.2.1 ROOF ROBOTIC WELDING STATION
10.3 OUT-PUT STORAGE

11.0 ROOF ACCEPTANCE STAND & LEFT OVER WELDING STATION

13.0 ROOF ACCEPTANCE STAND & LEFT OVER WELDING STATION
13.3 OUT-PUT STORAGE

UNDER FRAME SUB ASSEMBLY LINE

15.1 IN-PUT STORAGE
15.2 MANUAL TACK WELDING STATION
15.3.1 ROBOTIC WELDING STATION
15.3 RE-WELDING STATION
15.4 HANDLING TOOL
15.5 JIB BOOM CRANE

16.1 PART STORAGE FOR MIDDLE FRAME
16.2 MANUAL TACK WELDING STATION
16.3.1 ROBOTIC WELDING STATION
16.3 REWELDING (TOP SIDE)
16.4 OUT-PUT STORAGE

17.1 IN-PUT STORAGE(CORRUGATED SHEET)
17.2 CORRUGATED SHEET TACK WELDING STATION
17.3 OUT-PUT STORAGE

18.2.1-A CORRUGATED SHEET ROBOTIC WELDING STATION (BOTTOM)
18.2.1-B CORRUGATED SHEET ROBOTIC WELDING STATION (TOP)
18.3 REWELDING
18.3 OUT-PUT STORAGE

19.2-A MANUAL WELDING, GRINDING & INSPECTION (BOTTOM)
19.2-B MANUAL WELDING, GRINDING & INSPECTION (TOP)
19.3 FINAL INSPECTION
19.4 OUT-PUT STORAGE
19.5 JIB BOOM CRANE

SHELL ASSEMBLY LINE

21.0 SHUTTLER
22.1 IN-PUT STORAGE
22.2.1 ROBOTIC WELDING STATION
22.3 OUT-PUT STORAGE & OVER WELDING STATION
22.4 HANDLING TOOL

LHB Coach Shell Manufacture

SIDEWALL FABRICATION

END WALL FABRICATION

ROOF FABRICATION

UNDER FRAME FABRICATION

SHELL ASSEMBLY

Fabrication of Side Wall

1.Manual Tack Welding Station

2. Robotic Skelton Welding Station

3. Robotic Spot Welding Station

Tack Welding Of Side Wall Skin With Frame

Full Mig Welding Of Frame Members

Spot Welding Of Side Wall Skin With Frame

Cont….

Fabrication of Side Wall

4. Robotic Roof Bearer Fabrication

Complete Mig And Spot Welding Of Stiffner With Carline

5. Sidewall And Roof Bearer Welding

Welding Of Roof Bearer With Sidewall

6. Manual Welding Station

Back Piece Welding And Completion Of Work

Fabrication of Roof

1. Robotic Spot Welding Station

Robotic Spot Welding Of Roof Sheet With Carline

2. Tack Welding Station

Spot Welded Roof Sheet Tacked With Front Sheet

Cont....

Fabrication of Roof

3. Robotic Mig Welding Station

Robotic Mig Welding of Roof Sheet and Back Pice

4. Manual Roof Completion Station

Manual Touch Up for Complete Welding of Roof Sheet and Carline

Fabrication of Under Frame

1. Welding of Front Part Station

Manual Tack Welding of Cross Member and Sub Assembly to Made A Front Part

2. Robotic Welding of Front Part Station

Robotic Full Welding of Cross Member and Sub Assembly To Made A Front Part

Cont....

Fabrication of Under Frame

3. Tack Welding Station Of Middle Part

Tack Welding of Front Part With Cross Member and Sub Assembly to Made A Middle Part

4. Robotic Full Welding Station Of Middle Part

Robotic Full Welding of Midlle Part

Cont….

Fabrication of Under Frame

5. Welding of Trough Floor Station

Manual Tack Welding of Floor Sheet on Middle Part

6. Robotic Welding of Trough Floor Station

Full Welding of Floor Sheet From Back Side with Middle Part

7. Plug welding of Trough Floor Station

Full Welding of Floor Sheet on Top Side and Plug Welding

Cont....

Fabrication of Under Frame

8. Manual Welding of Under slung Components

Manual Welding of Under Slung Parts and Console Bracket etc.

9. Manual Welding of Channel Part Station

Manual Welding of Channel and Bracket at Top Side of Floor

10. Completion Station

Finishing and Completion Manually

Fabrication of End Wall

1. Tack Welding Station

Tacking of Member Part and Assembly at Different Stages

2. Robotic Full Welding Station

Robotic Welding of Tacked Components of End Wall Part

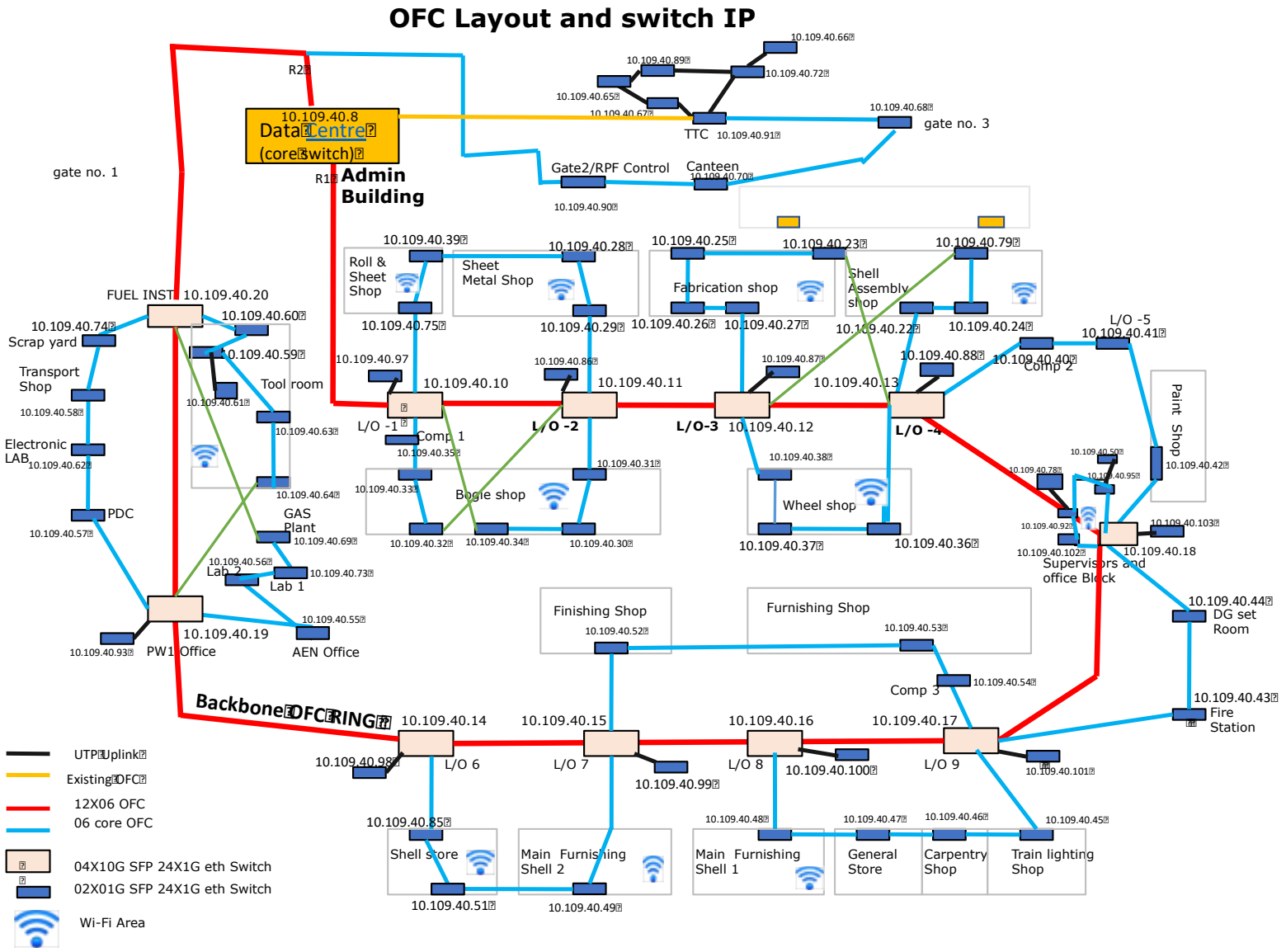
Work Centers for Shell Manufacture

Details of Work Centres/ Robots/Controllers deployed in the Shell Shop								
S. No.	**Type**	**Side Wall**	**End Wall**	**Under Frame**	**Roof**	**Shell Assy**	**Total**	**Controllers**
1	Robotic W/S	8	2	4	2	2	18	
A	Robots	12	2	16	2	4	36	Fanuc, B&C
B	Controller	12	2	16	2	4	36	Fanuc R30i /Siemens 840DSL
C	HMI	8	2	4	2	4	18	Sinumeric
2	Manual W/S	4	4	8	3	5	24	
	Total Work Centers	12	6	12	5	7	42	

Details of Machines & Controllers

SN	Shop Name	Machine Type	Purpose	Prgmng Software	USB	Ethernet	Operating System
1	Manufacturing Shop	Cut to length cum Slitter Lite	Converting Coils into sheet sizes				
2	Manufacturing Shop	CNC Laser Cutting and Welding M/c	Joining of sheets to make complete skin of side wall, followed with edge trimming and window Blanks	Lantek Expert	Y	Y	PCU CARD
3	Manufacturing Shop	CNC Laser Cutting Machine	Intricate profile cutting of components	Lantek Expert	Y	Y	Window XP
4	Manufacturing Shop	CNC Fibre Laser cutting Machine	Intricate profile cutting of components	Lantek Expert	Y	Y	Window 7
5	Manufacturing Shop	CNC Shear Centre	Cutting of sheet into different size as per Requirement	------	Y	Y	
6	Manufacturing Shop	CNC Stretch Bending Forming M/c	Car line forming	------	Y	Y	Window XP
7	Manufacturing Shop	CNC Folding Machine	For Bending	------	Y	Y	
8	Manufacturing Shop	CNC Press Brake Machine 120T	For Bending	------	Y	Y	
9	Manufacturing Shop	CNC Press Brake Machine 440T	For Bending	------	Y	Y	
10	Manufacturing Shop	CNC Press Brake Machine 880T	For Bending	------	Y	Y	
11	Manufacturing Shop	Hydraulic Press 800T	For Blanking/Forming				
12	Shell Sub Assembly Shop	Robotic SPOT Welding	For joining members with skin sheet	STEP 7 Version 5.5	Y		
13		CNC Robotic Spot Welding Machine	For joining members with skin sheet	RoboCAD	Y	Y	Window XP
14		Robotic Side wall assembly line	For Fabrication work, Joining members to make a sub assemblies, Like Side wall, Endwall, Roof and Underframe	STEP 7 Version 5.5	Y		
15		Robotic End wall assembly line					
16		Robotic Roof Fabrication line					
17		Robotic Underframe fabrication line					
18	Shell Assembly Shop	Robotic Shell Assembly line	For Joining Different Subassemblies(Side wall, Roof, Endwall and Underframe) to make a Coach shell				
19	Shell Assembly Shop	Manual Shell Jigs					
20	Shell Assembly shop	Magnetic Skin Tensioning	For Stress relieving				
	Area proposed under TMIR Project						

MCF OFC Layout



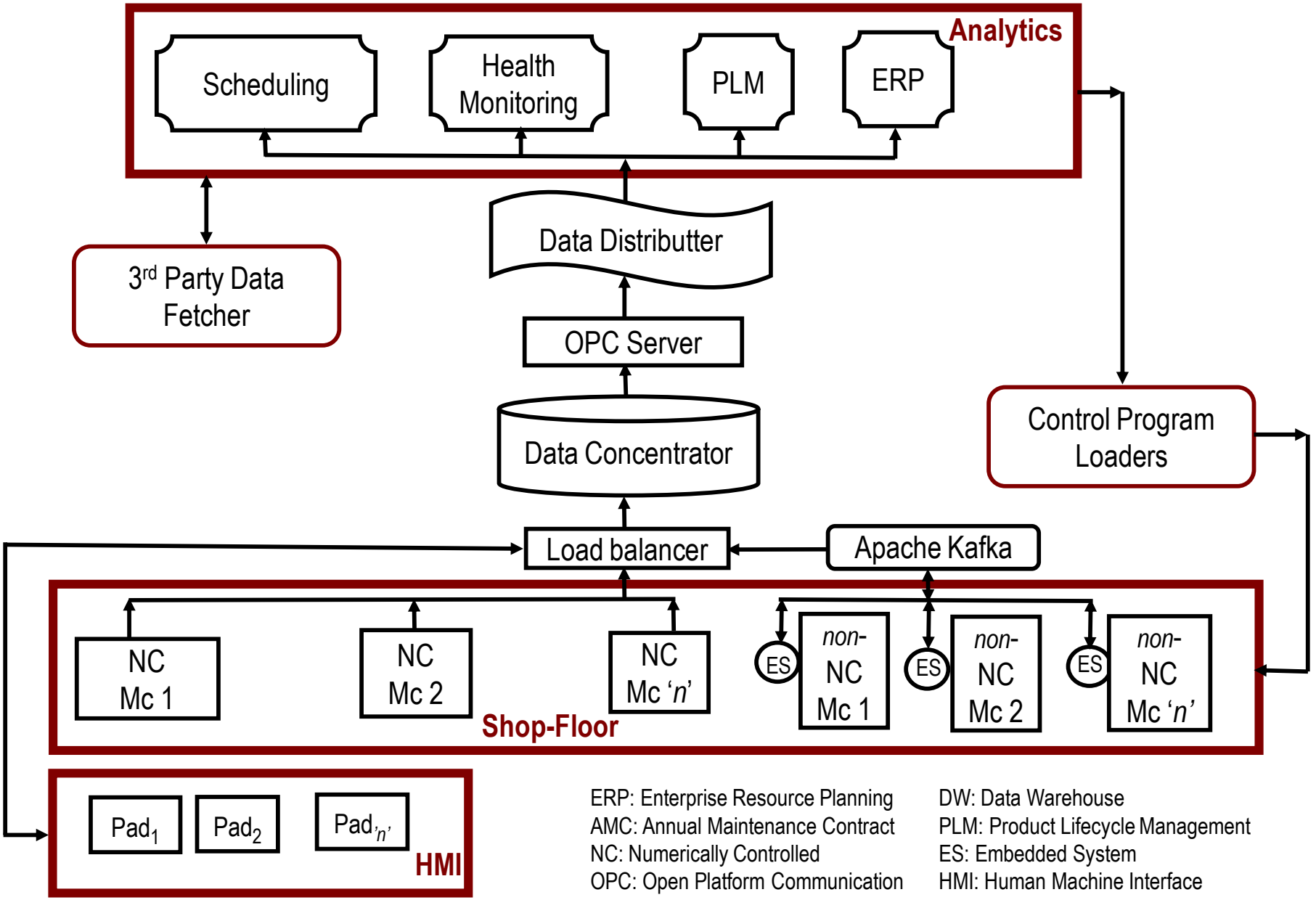
Implementation Overview

Manufacturing Execution System (MES) to Industry 4.0 standards			
Mfg Enterprise Solutions Ass'n (MESA- II) ANSI/ISA- 95			
	Design/ Planning	CAD, Simulation, Integration, CAM/ CAE, Digital Twinning	Microsoft Dynamics 365 Unigraphics NX, Weldcude, FANUC MT- LINK*i*, ROBOGUIDE, Siemens PLM Software, Sinumerik Kuka Robot Language (KRL)
	Net-working	Networking	Totally Integrated Automation Open Platform Communications Process Field Bus (PROFIBUS) & Ethernet for Control Automation
	Produc-tion	Shop	Distributed Control Systems Supervisory Control & Data Programmable Logic Controllers
		Sub-Shop	
		Activity Centre	
		Work Centre	

4- Levels	Proposed in a gradual manner											
Shop	Various Shops											
Sub- Shops	Inspection			Machinery			Welding			Measurement		
Activity Centres	1 or Many			1 or Many			All locations			1 or Many		
Work Centres	1	2	3	1	2	3	1	2	3	1	2	3

- Various packages, systems, applications and Hardware within Design/Planning, Networking and Production to be added in a modular and incremental manner;
- Various shops within the industry establishment will be under the ambit of Industry 4.0 for areas such as Inspection, Machining, Welding, Measurement etc. These can further be divided into activities and work centres.
- The aggregation of the above in a Industry 4.0 generic application Package such as that which has been implemented in MCF.
- An add on ERP in Microsoft Dynamics to enable user friendly MIS through popular applications such as Word and Excel on desktop/smart phones.

Proposed Architecture



ERP: Enterprise Resource Planning
AMC: Annual Maintenance Contract
NC: Numerically Controlled
OPC: Open Platform Communication
DW: Data Warehouse
PLM: Product Lifecycle Management
ES: Embedded System
HMI: Human Machine Interface

Networking

- All the shops are properly networked using gigabit interfaces.
- Wireless networking will also be supported
- Required Central computer system will be placed in existing data center
- A set of various servers will act as data concentrator backbone
- Push-Pull data logging system will be supported

Data Logging

- All the network ready machines will send data to data concentrator
- All machines will send health related data also.
- A Network Interface Unit(NIU) (one for each Raw machine) will be designed which will push data into data concentrator. This NIU will be wireless ready
- Data format for standard data will be standardized
- Data format for Health data will be standardized
- Data frequency will also be standardized (Per machine)
- Some data logger units will be placed across the various shop at various strategic point to know the resource health and environment inside a shop.

Schedule Optimization

- Analysis outcome will provide the optimized usage of every machine.
- Shop expansion plan will be generated using analysis outcome

Inefficiency cum under utilization Indicator

- Dynamic analysis outcome will predict the Inefficiency pointer
- It will also indicate under utilization related issues.

Productivity Indicators

- Provide the following productivity indicators
  - for machine, shop, plant
- Current Order Status
- Capacity to cater future orders
- Expansion requirement to cater future orders
- Schedule for expansion in phased manner

Health Monitoring

- Monitoring of Machines
- Monitoring of Process
- Monitoring of Products

Failures and Down time

- Machine uptime
- Cascaded effect on product line for a given failure
- How to achieve failure independence

Further Analytics

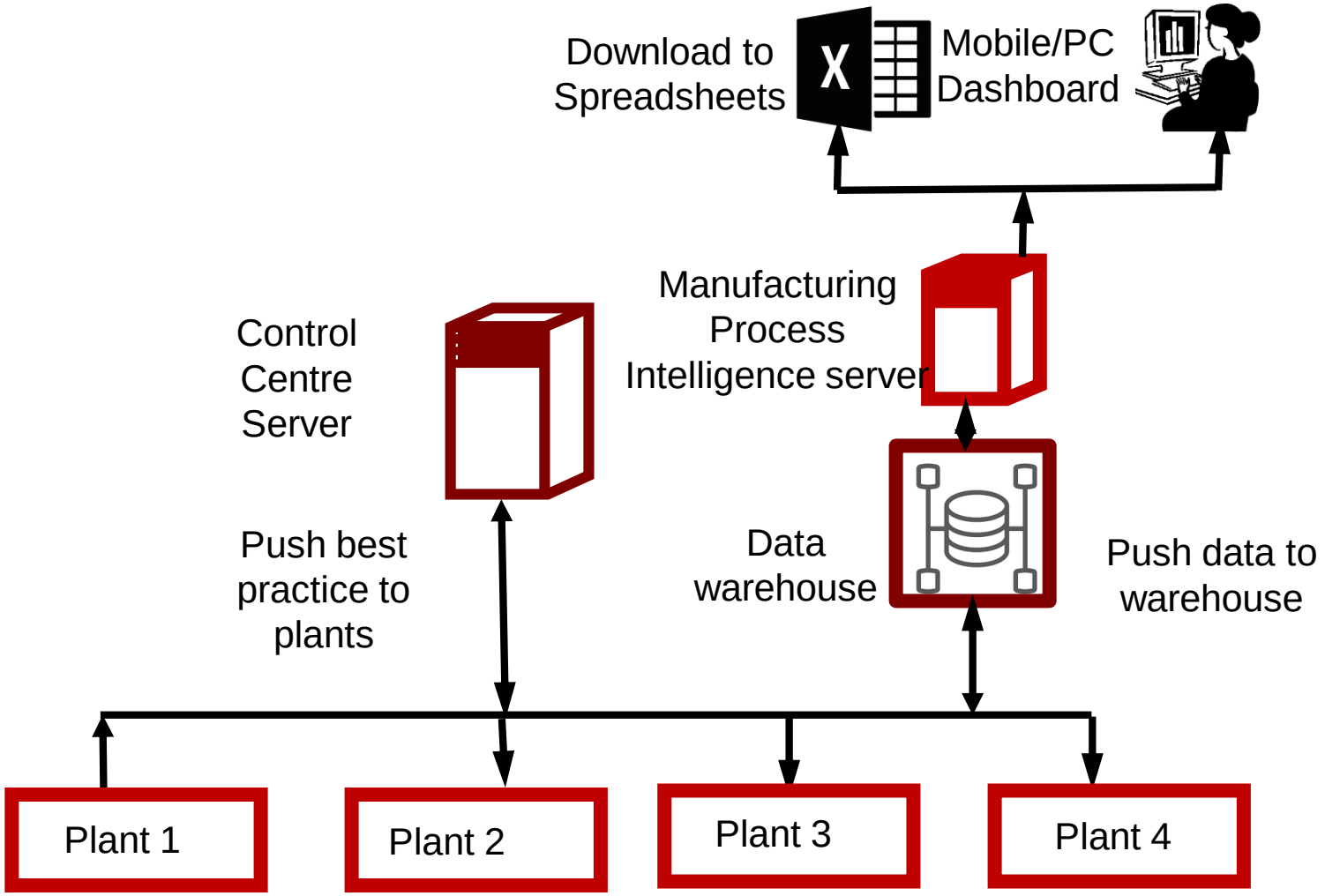
Production Intelligence
- Order Adherence to plan
- Yield Analysis
- 200+ Measures & KPIs

Quality Intelligence
- Test Equipment Performance
- Root Cause Analysis
- Inspection Analysis
- 200+ Measures & KPIs

Labor Intelligence
- Labor Availability
- Labor Utilization
- Units per Labor hours
- 205 Measures & KPIs
- 90+ Measures & KPIs

Machine Intelligence
- Overall Equipment Effectiveness
- Unplanned downtime
- 70+ Measures & KPIs

Scale Up


Download to Spreadsheets
Mobile/PC Dashboard
Manufacturing Process Intelligence server
Control Centre Server
Data warehouse
Push best practice to plants
Push data to warehouse
Plant 1
Plant 2
Plant 3
Plant 4

Design Twin – Design Innovation

Automatic train control & Signal Modules

Virtual Lab

Train control & monitoring systems

Software module

3d model of infrastructure

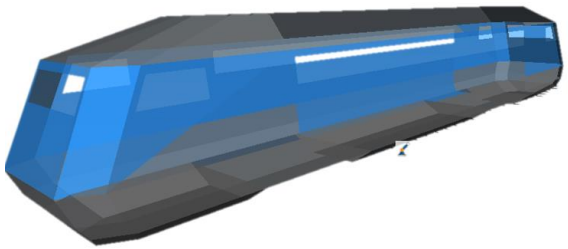
Including station & Crossway

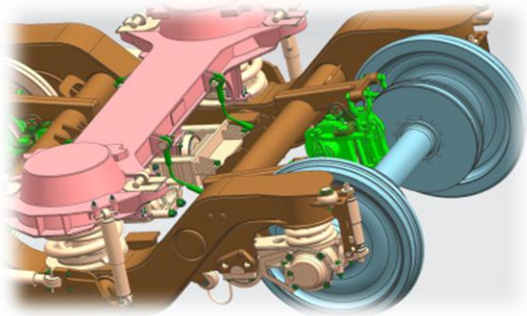
3d Virtual model of train, including assembly and components

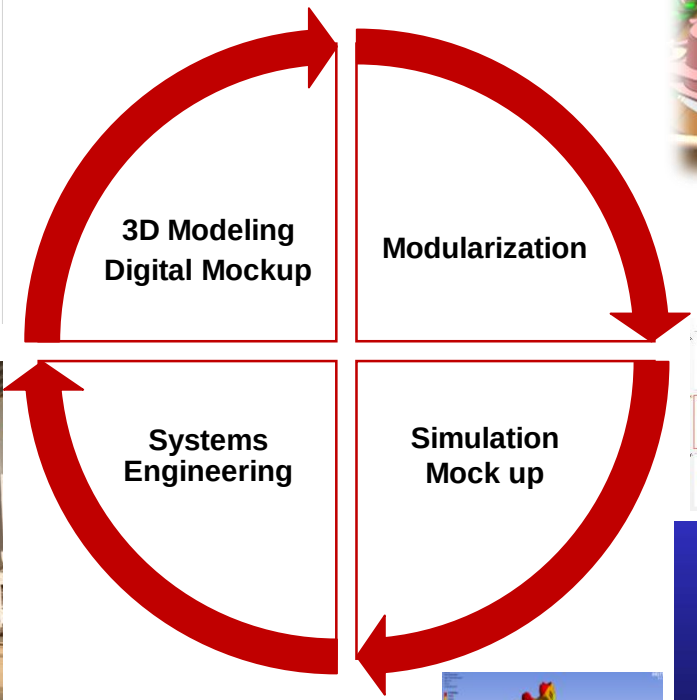
Multi-physics model of complete train and subsystems of coaches

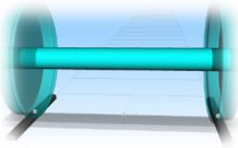
Digital Twin

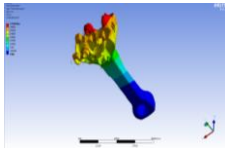
Mechanical / System / Electrical integration

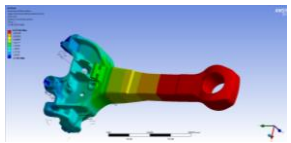


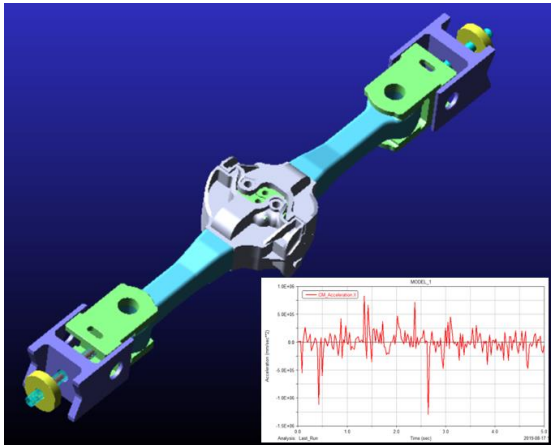




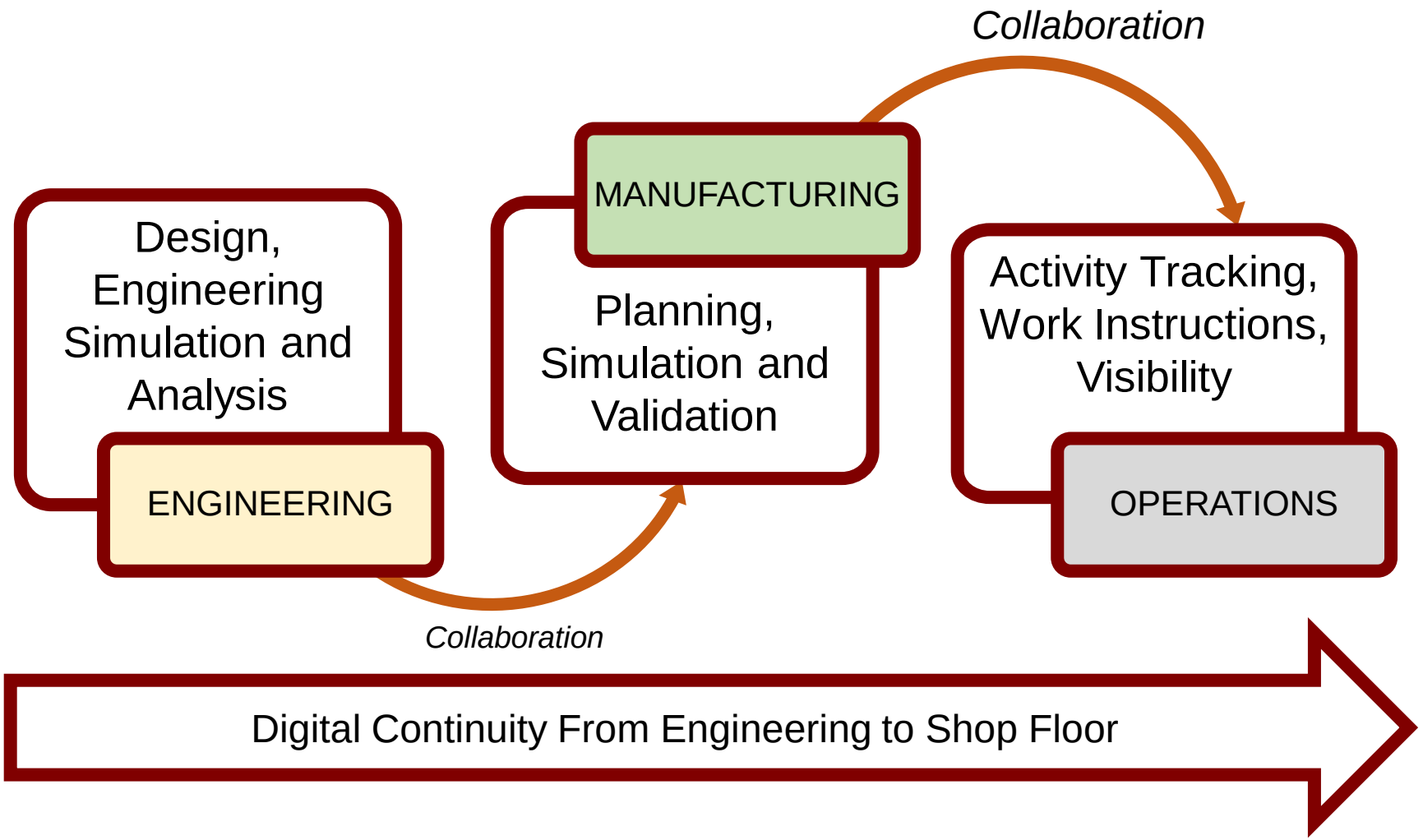






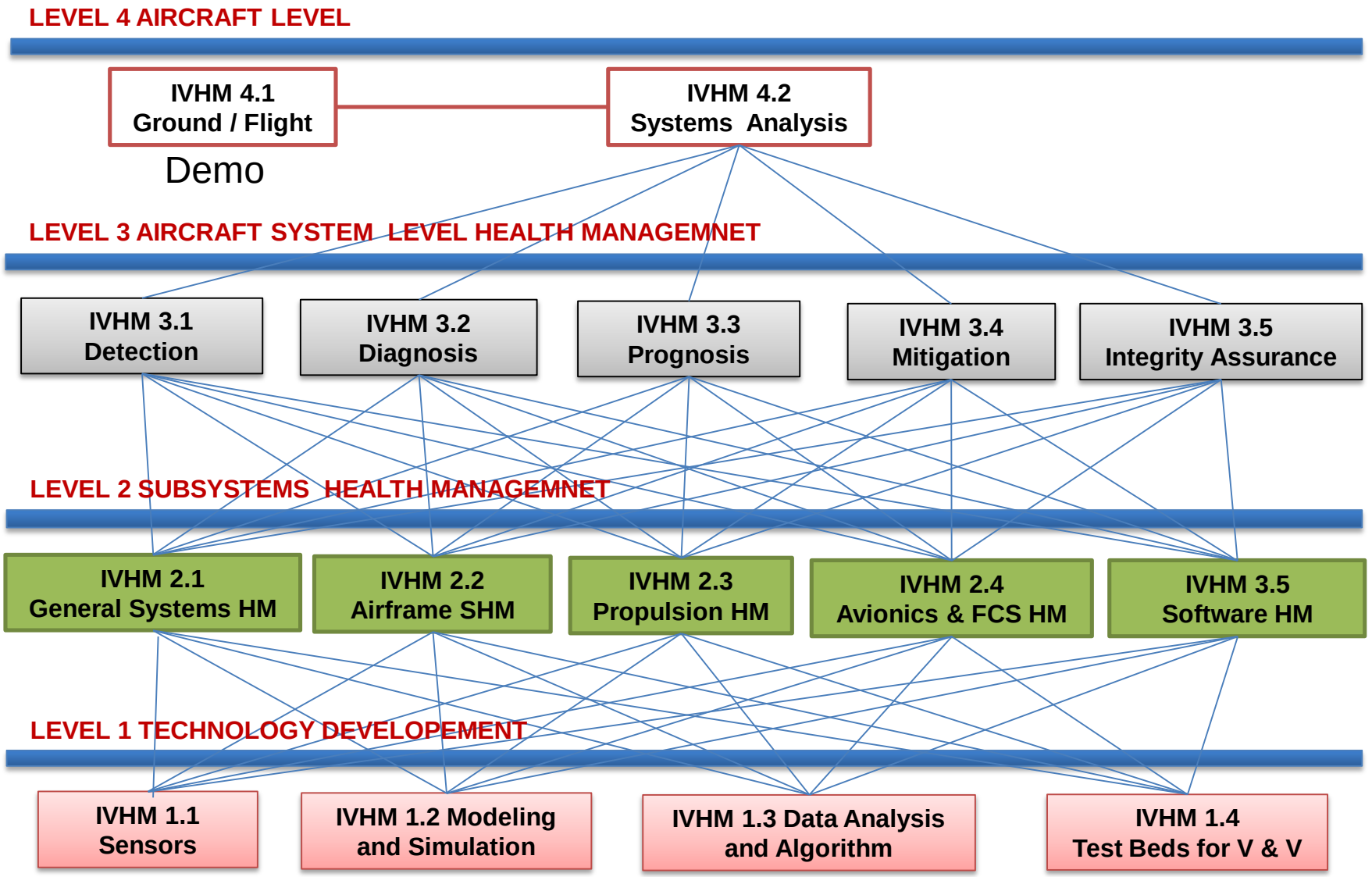


Integration



I - 4.0
Railway Asset Management System

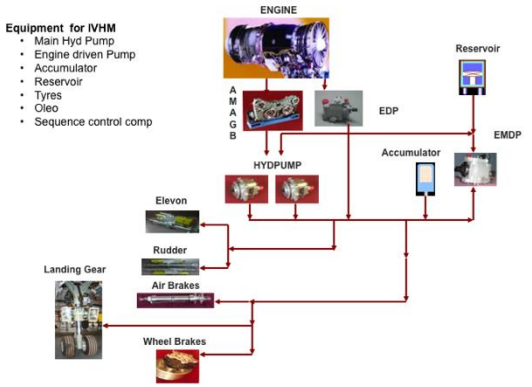
Aerospace - IVHM



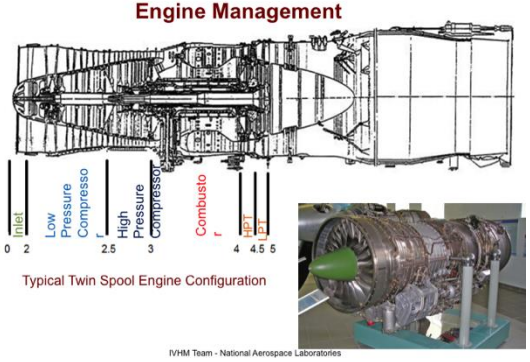
Ref: NASA IVHM tech plan

Aero – Sub-Systems

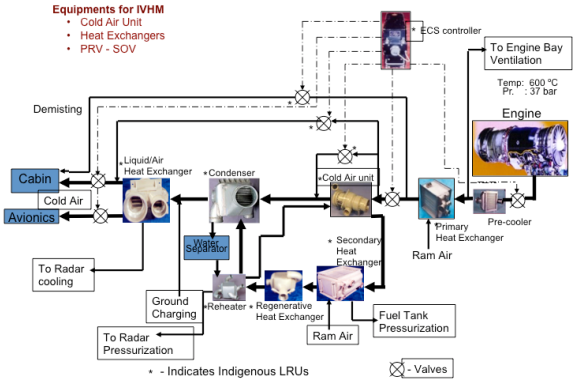
Hydraulic and Landing Gear System



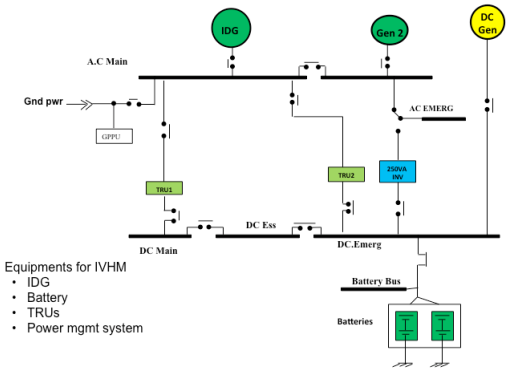
Engine Management



Environmental Control System (ECS)

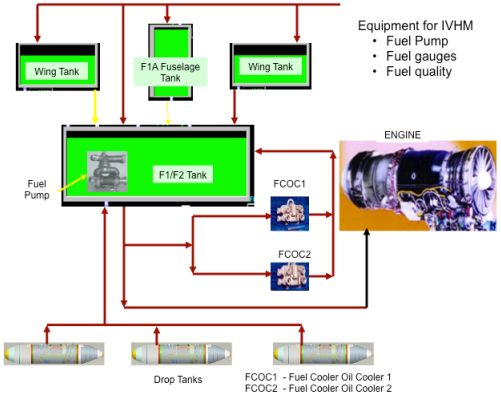


Electrical System



Equipments for IVHM
- IDG
- Battery
- TRUs
- Power mgmt system

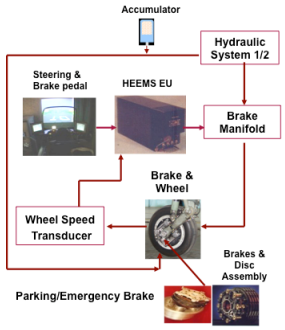
Fuel System



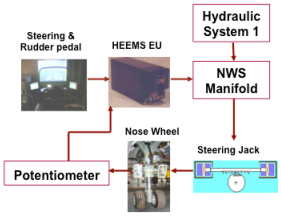
Equipment for IVHM
- Fuel Pump
- Fuel gauges
- Fuel quality

HEEMS EU – Hydraulic Electrical Engine Management System Electrical Unit

Brake Management System



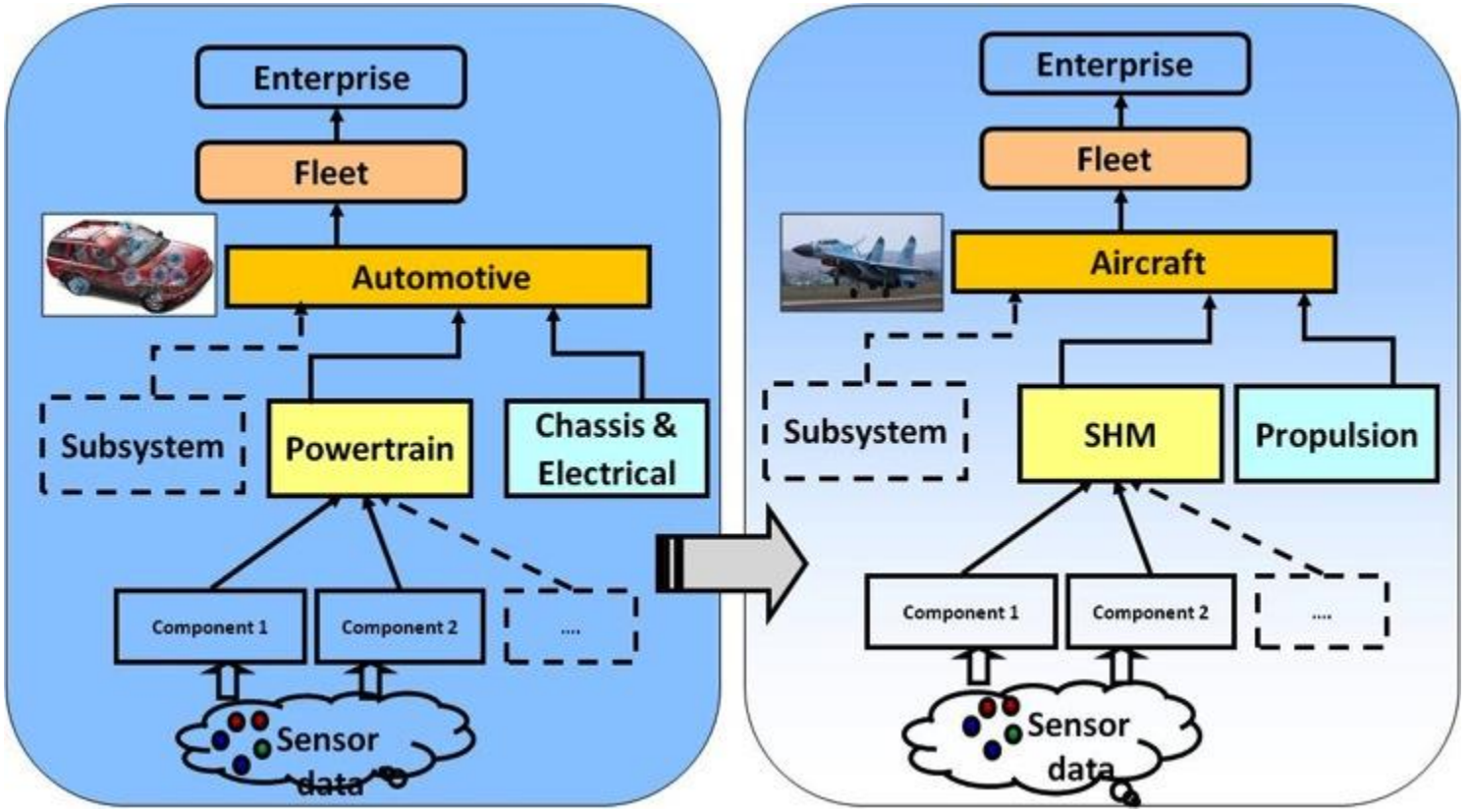
Nose Wheel Steering System



Equipment for IVHM
- Brake Servo Manifold
- Nose Wheel Steering manifold
- Brake Unit

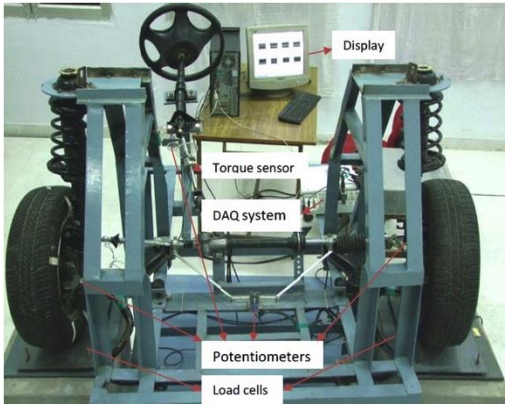
Automotive IVHM

Architectures for Automotive and Aerospace



Automotive Subsystem Level Health Management

Steering Subsystem



Test-Beds Instrumentation
Models Algorithms

Instrumented Vehicle

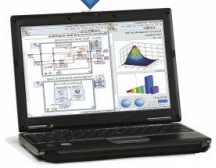
Rugged DAQ system with cRIO controller & Modules

Voltage
Sound
Strain
Vibration
Temperature
Digital pulse
Current
CAN signal

Signals from various sensors

Instrumented TATA Indica

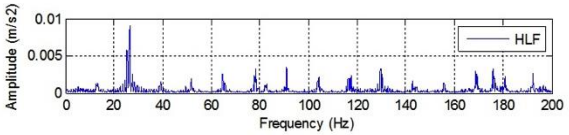
MEMS IMU



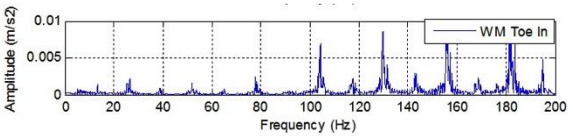
Laptop running DAQ software & storage of collected data

Braking Subsystem

Healthy State



Vehicle with Misaligned Wheel



Methodology

Rapid Control Prototyping

I. Neural Network
II. Fuzzy Logic

Application/ Calibration

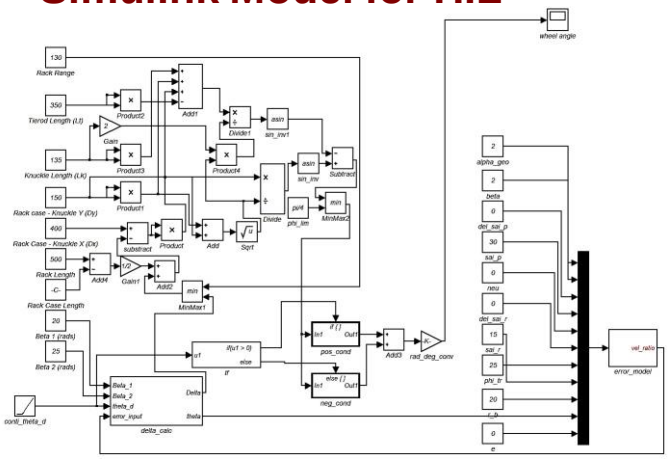
Function Design

I. Fault Simulation
II. Data generation
(a) Test bed
(b) Vehicle
III. Analysis Model Development
IV. Diagnosis Code

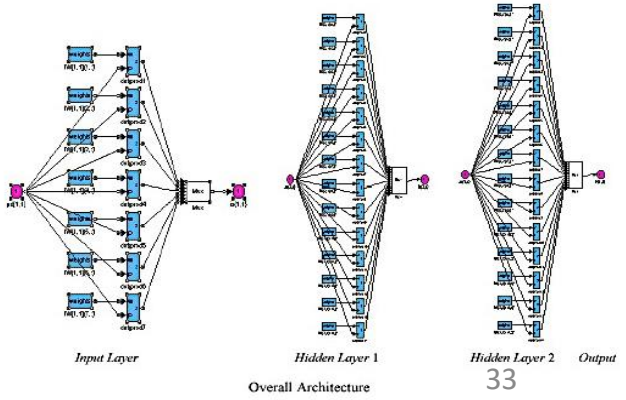
Hardware in-Loop (HIL)

Target-Code Generation

Simulink Model for HIL

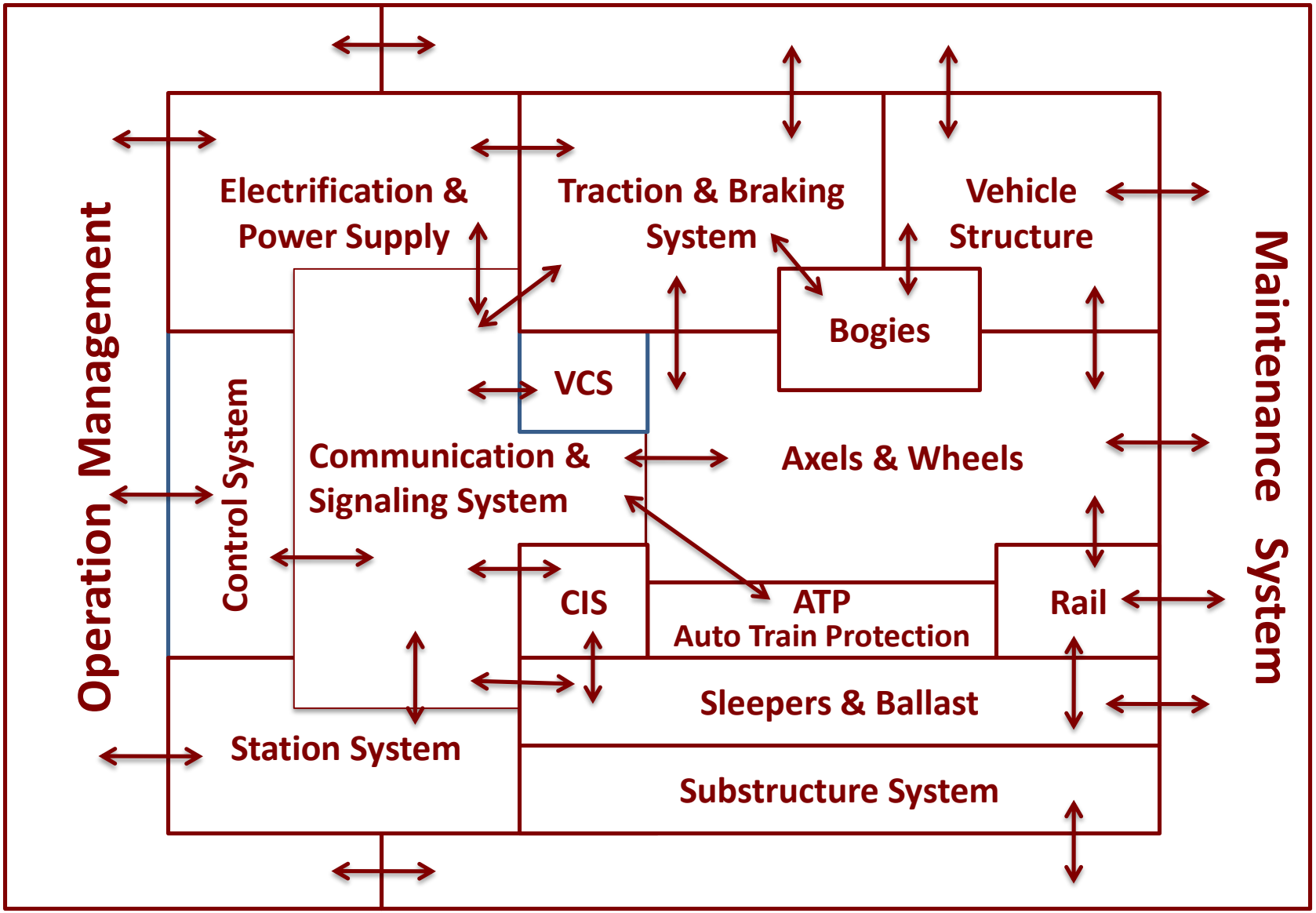


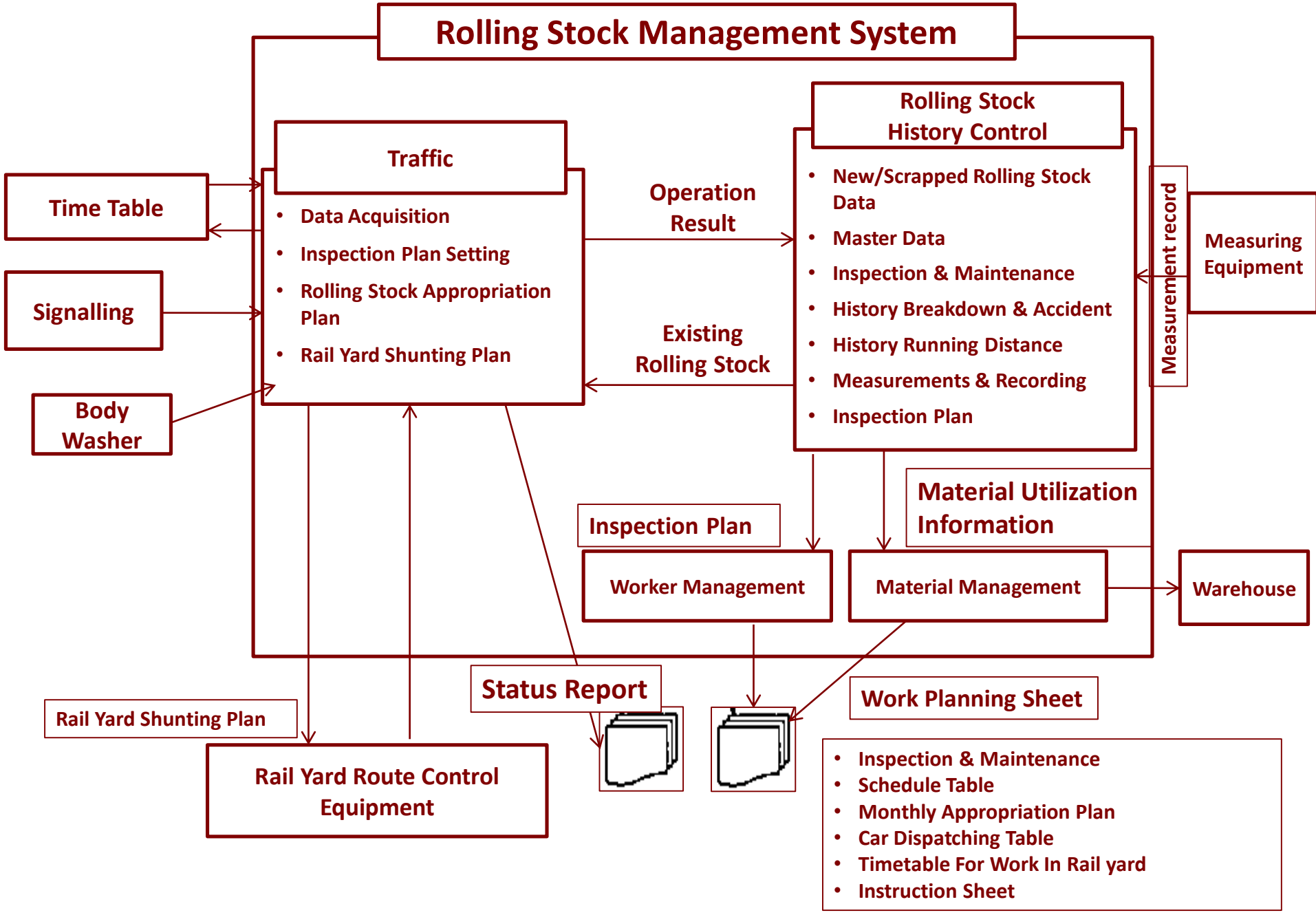
Neural Network



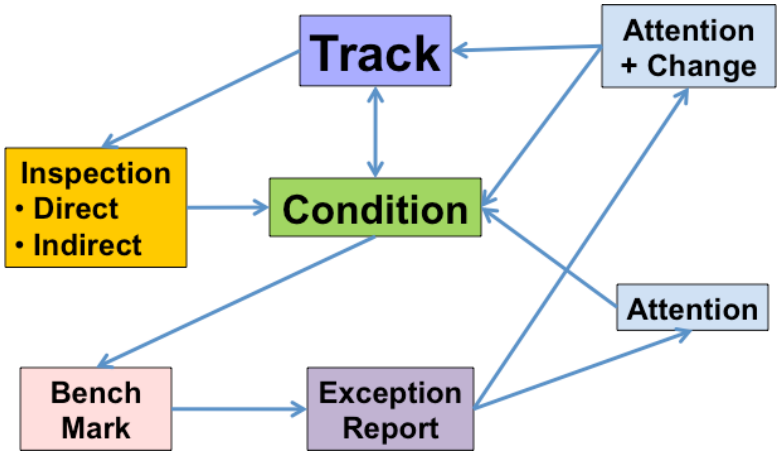
Overall Architecture

SYSTEM of Systems: Railways




Rolling Stock Management System
Traffic
Data Acquisition
Inspection Plan Setting
Rolling Stock Appropriation Plan
Rail Yard Shunting Plan
Time Table
Signalling
Body Washer
Operation Result
Existing Rolling Stock
Rolling Stock History Control
New/Scrapped Rolling Stock Data
Master Data
Inspection & Maintenance
History Breakdown & Accident
History Running Distance
Measurements & Recording
Inspection Plan
Measurement record
Measuring Equipment
Material Utilization Information
Inspection Plan
Worker Management
Material Management
Warehouse
Status Report
Work Planning Sheet
Rail Yard Shunting Plan
Rail Yard Route Control Equipment
Inspection & Maintenance
Schedule Table
Monthly Appropriation Plan
Car Dispatching Table
Timetable For Work In Rail yard
Instruction Sheet

Railway Track Management System



Inputs

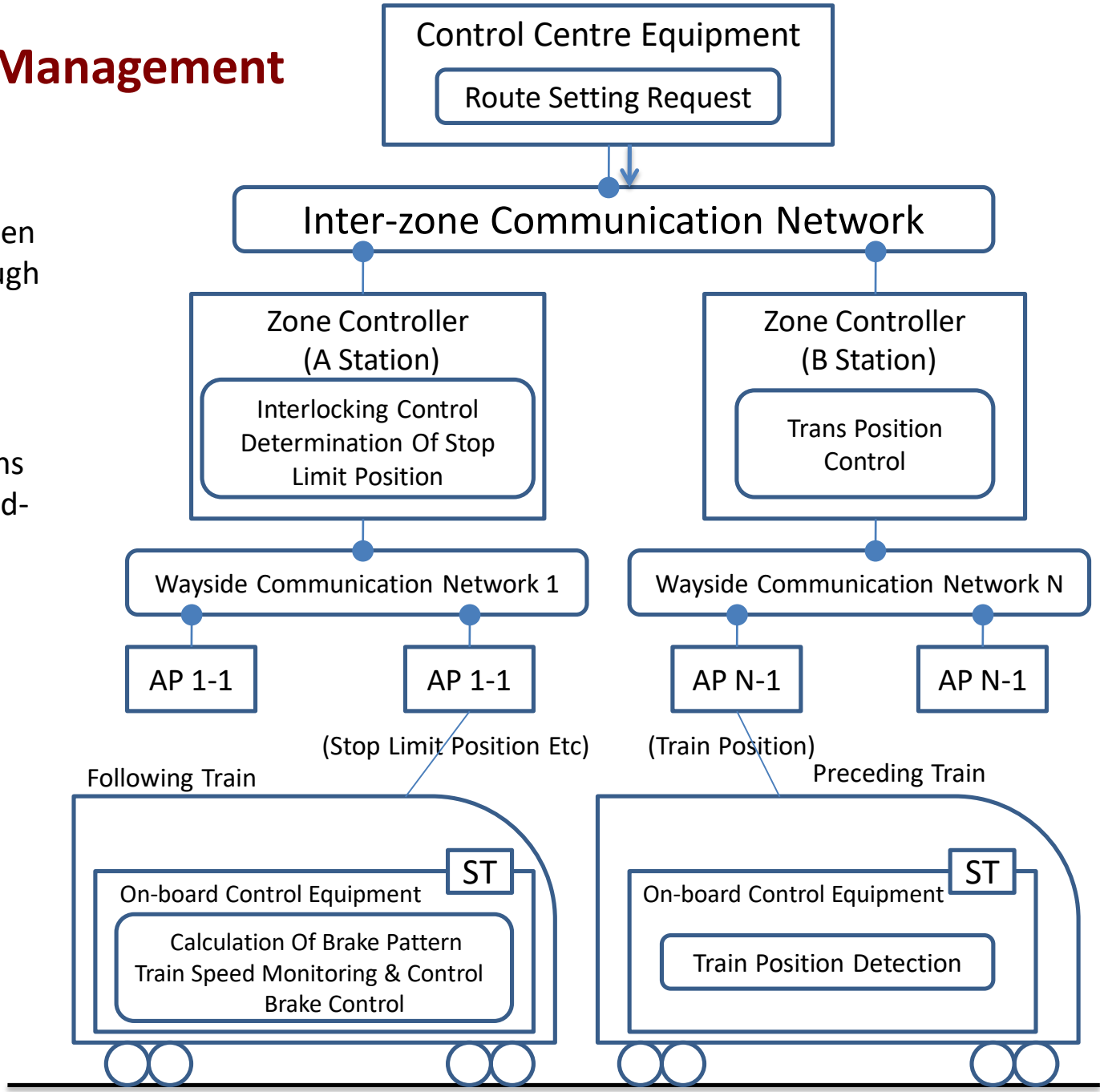
- **Initial – One time**
  - Jurisdiction and domain data
  - Master Assets (All – Rail, sleeper, welds, joints… everything) with correct chainage
  - One last inspection from all inspection registers
- **Periodic**
  - Sanctioned works (once a year)
  - GMT (once a year)
- **Regular Working**
  - All Inspections (Individual assets, trolleys, etc.)
  - TRC/OMS/Oscillograph results
  - USFD testing
  - All Works (Maintenance, Renewal, Machines, gang input, etc..)
  - Track machine work
  - Contractual works/inputs

Outputs

- **Master Asset related :**
  - Jurisdiction and domain data
  - Assets classification & exception
  - Track statistics
- **Inspection related :**
  - Inspection Planning, Inspection charts
  - Due/Overdue, Shortfall
  - Quality, Pending compliance
- **Asset Condition related :**
  - Various Reports (Xing worn beyond limit, curve needing local/re-alignment, rail corroded/worn, etc)
  - USFD classification, progress & condition related
  - Due D/s, renewal, tamping, etc
- **Work Related :**
  - Machine progress/quality,
  - Machine planning
  - Gang progress/utilisation

Signaling System Management

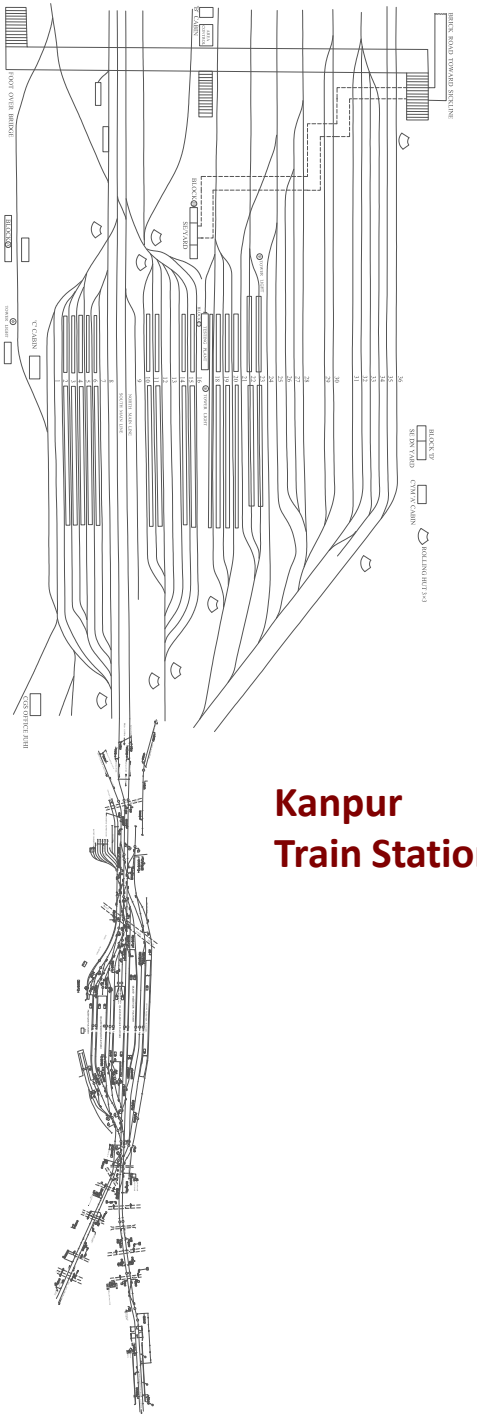
- Wireless Train Control System for communication between ground and train through a general purpose wireless system.
- The system controls intervals between trains without relying on fixed-blocks.



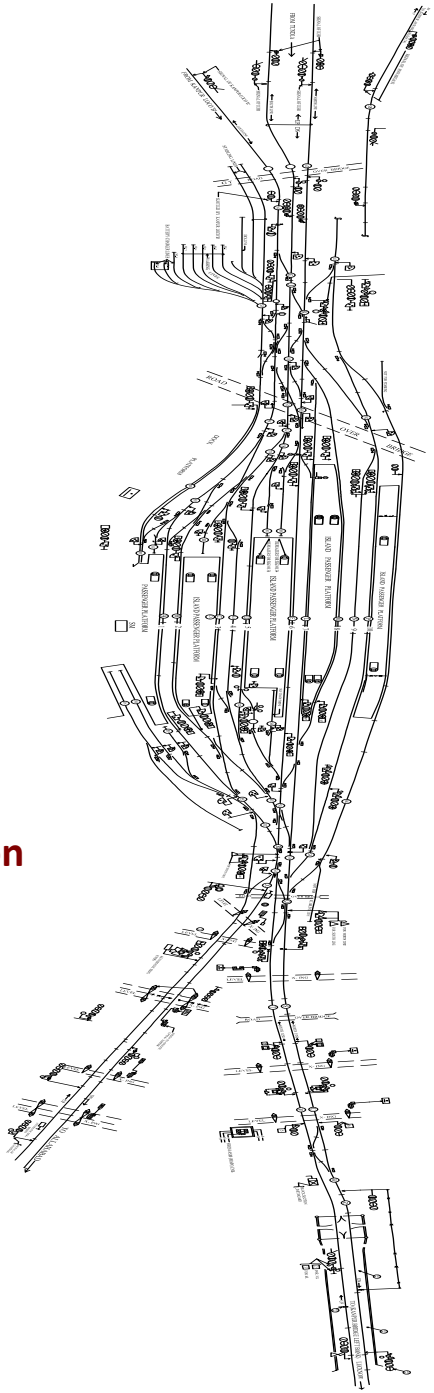
Scheduling

Some major scheduling processes are as follows.

- Locomotive Scheduling (Utilization)
- Locomotive Scheduling (Maintenance)
- Coach Scheduling Utilization
- Coach Scheduling Maintenance
- Rake Maintenance Scheduling
- Rake Scheduling (Operational Utilization)
- Driver Scheduling
- Signal Scheduling
- Guard Scheduling
- Other Running and Stationed Staff Scheduling
- Platform Scheduling
- Passenger Scheduling
- Track Usage Scheduling
- Water Filling Scheduling
- Track Maintenance Scheduling
- OH Power Calculation for their yearly usage
- OH Power Line Maintenance Scheduling
- Scheduled Railway Reservation for a train
- Train Scheduling

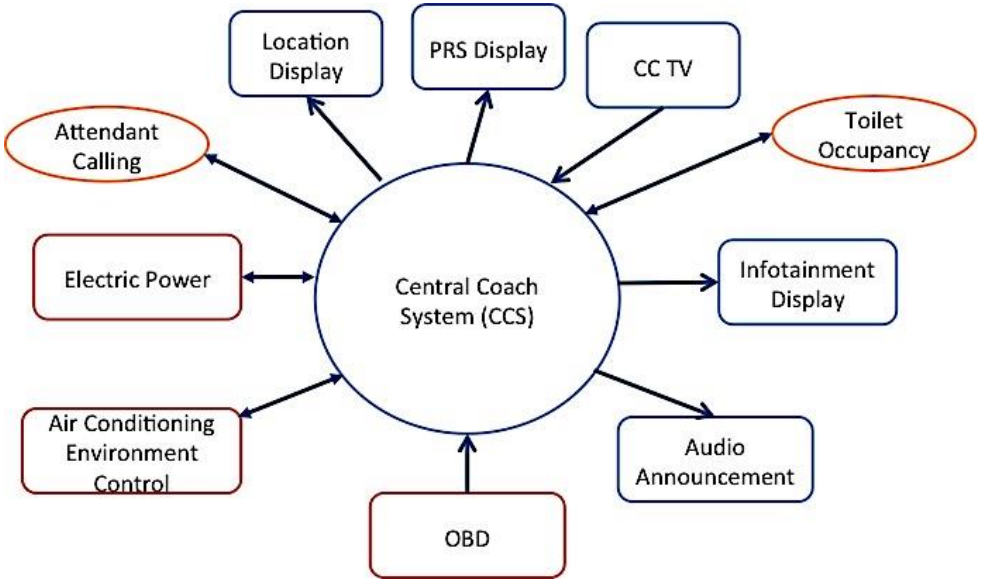


Kanpur Train Station



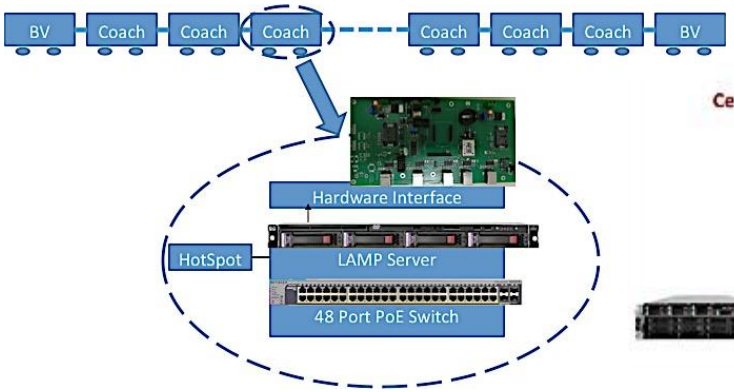
SMART Passenger Information & Coach Computing Unit (PICCU)

Multiple modules related to Passenger Information, CCTV, Infotainment, Coach Diagnostics, Condition Monitoring are proposed to be built.



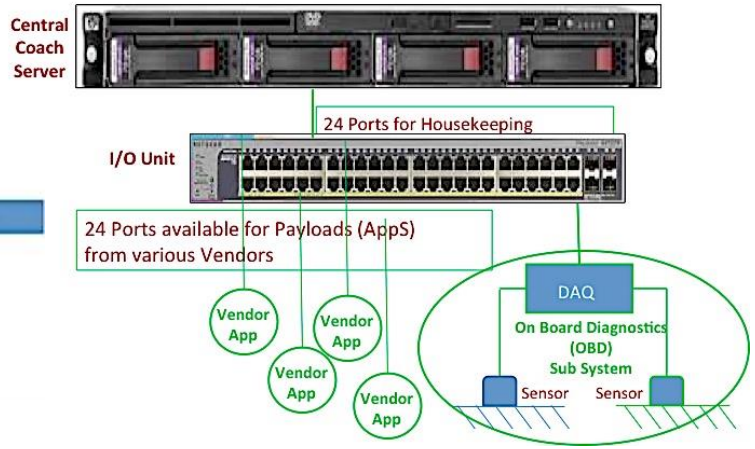
- Location Information Display (2)
- PRS Coach Related Data Display (2)
- Audio Announcement
- Coach On-Board Diagnostics, OBD
- Infotainment
- IP Based Cameras (8)
- Toilet Occupancy System
- Coach Attendant Calling System
- AC & Environment related Parameters / Control
- Power related Parameters (Voltage / Current etc)

Normal Coach Modular Design



Central Server to Coach Communication

Access to Vendors for Applications (AppS)



Deep Learning Protocol
for
Integrated Rail System Management (IRSM)

Aims to develop an Open Software Platform

for knowledge extraction

automated detection,

diagnosis, prognosis and decision making

that enable improve the overall efficiency and safety of the Railway System.

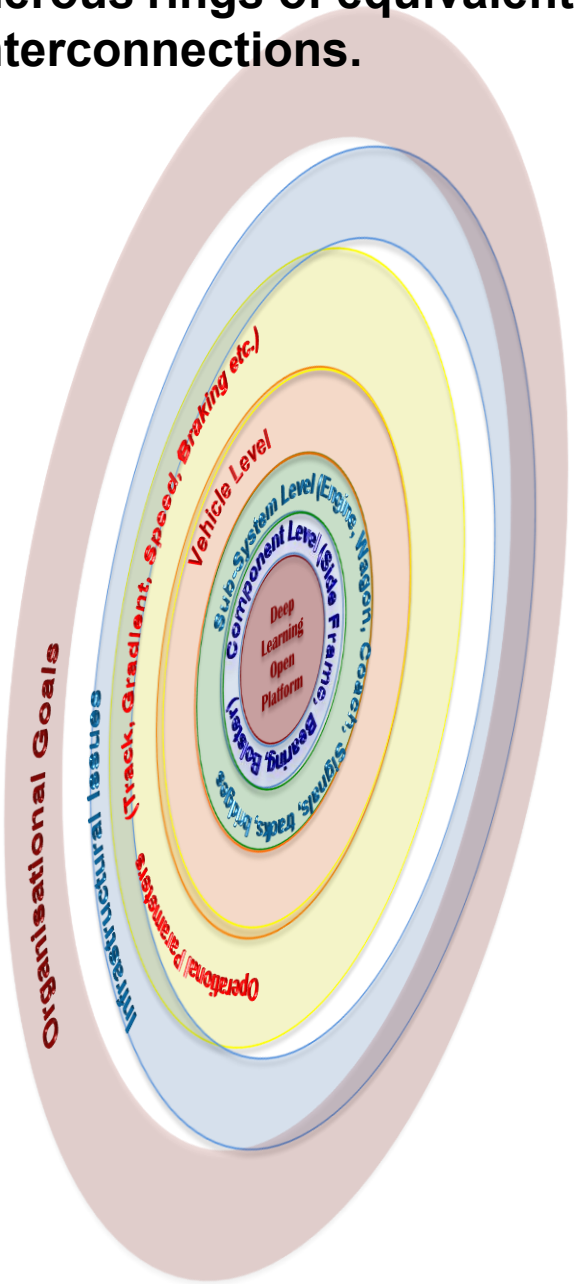
IRSM Configuration

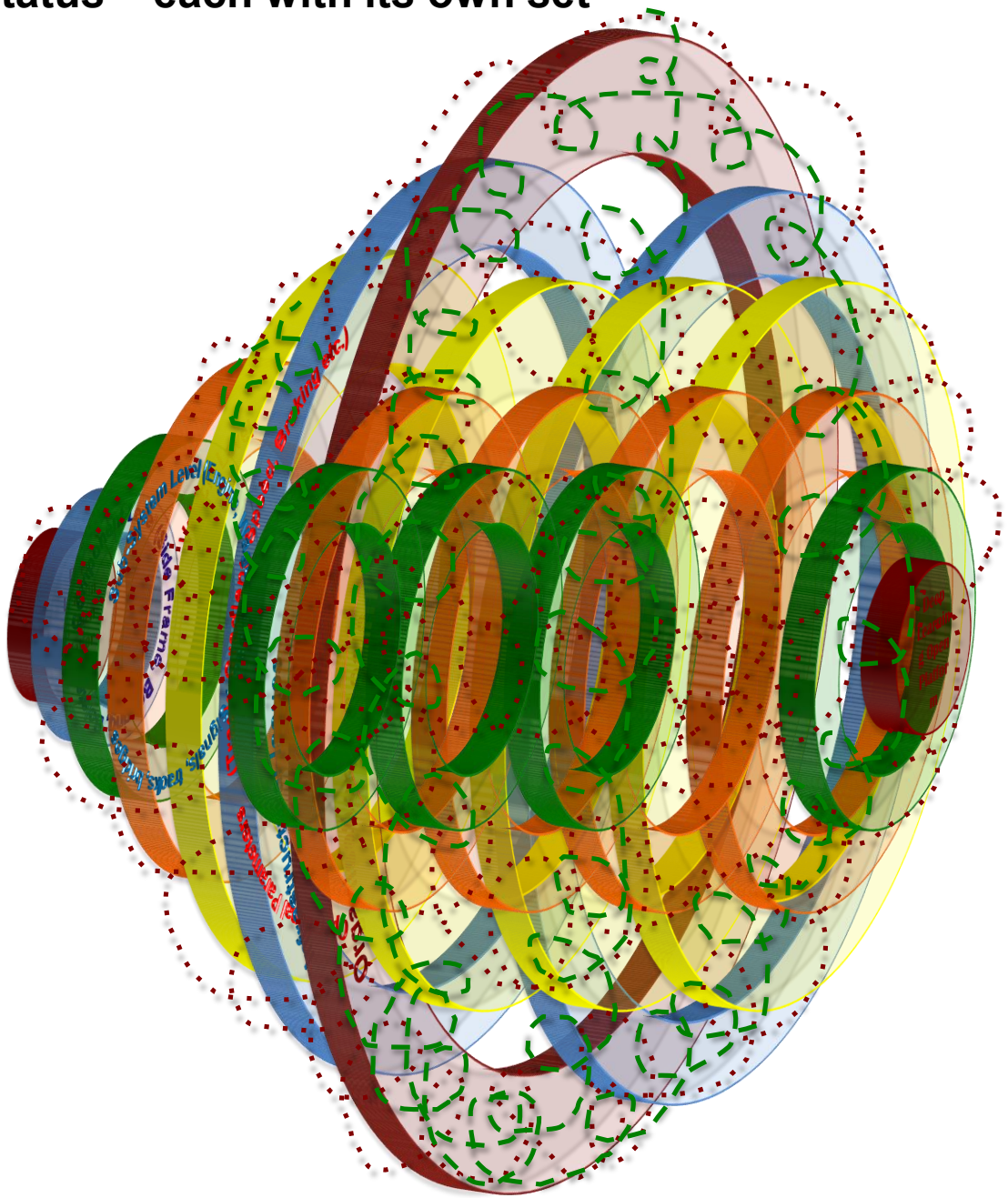
Integrated Railway System Management (IRSM) platform comprises –

- Component Level (e.g. Bearings, Side Frames, Bolsters etc.)
- Sub-System Level (e.g. Bogie, Coach, Locomotive, Track, Signals etc.)
- Vehicle Level (i.e. train / rake level)
- Operational Parameter Level (Track, Gradient, Speed, Braking etc.)
- Infrastructural Issues

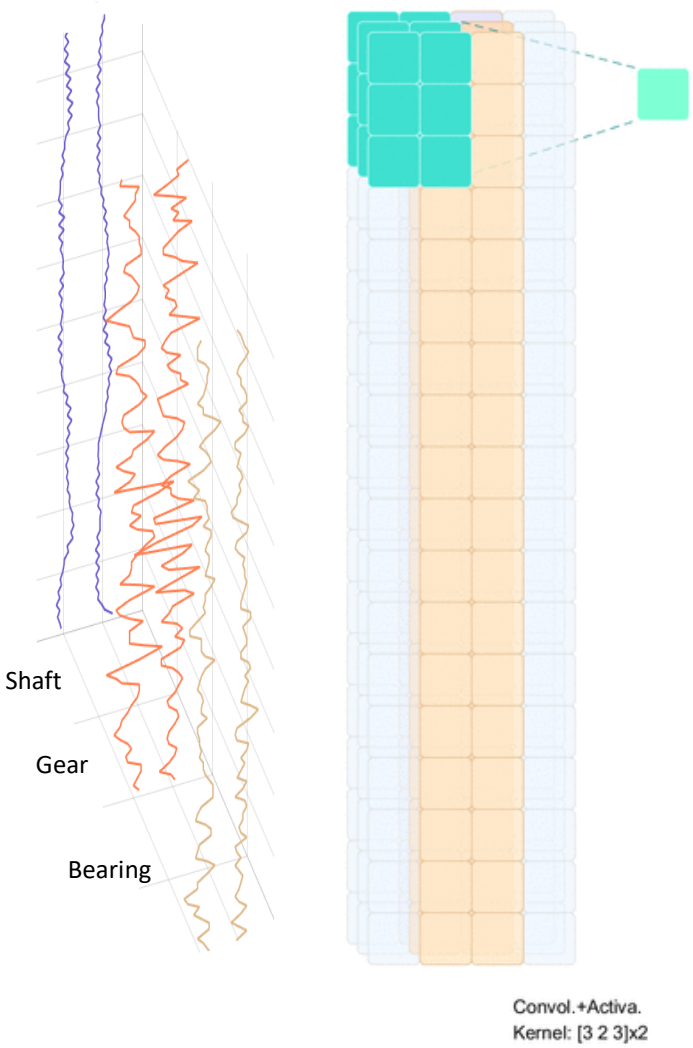
Topology

Each Concentric Ring, in would itself be an assembly of numerous rings of equivalent status – each with its own set of interconnections.





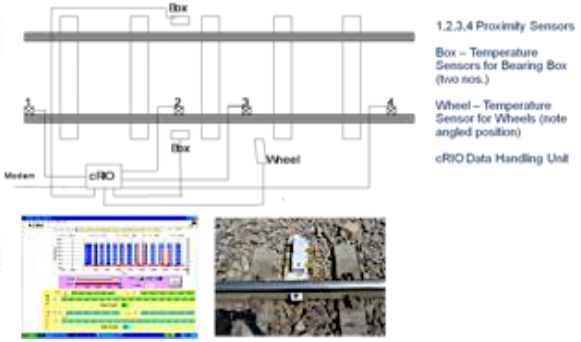
Deep Learning CNN



Previous Mission 2003 - 09

Derailment Detection Devices

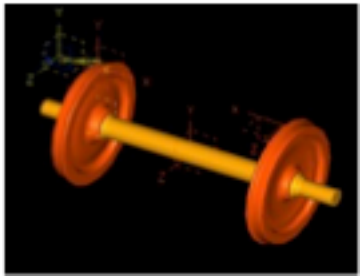
Sensors for Hot Boxes & Hot Wheels



Corrosion Prevention of Rails

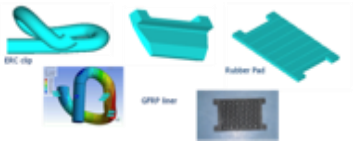
On-Board Diagnostics of Locomotives

Wheels & Axles of Improved Metallurgy

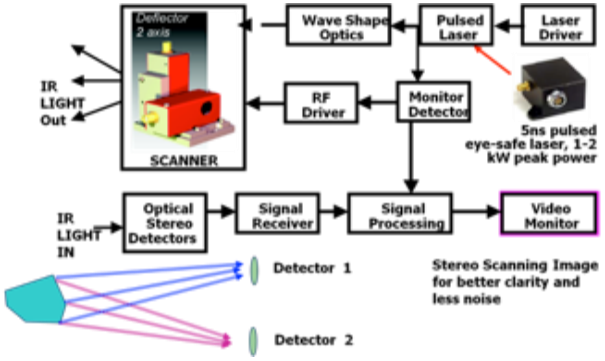


Measuring Wheel Technology

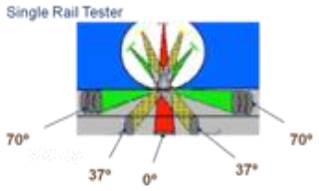
Improved Rail Fastenings



Fog Vision Instrumentation



Rail Flaw Detection Instrumentation



- Used for testing one rail at a time.
- Used for hand probing of welds.
- Used on fish plated track.

Satellite Imaging for Rail Navigation (SIMRAN)

Technology Mission for Indian Railways

A consortium of Ministry of Railways, Ministry of Human Resource Development, Ministry of Science & Technology and Industries on an Investment Sharing Model is being set up as part of **Technology Mission for Indian Railways** *to take up identified Railway projects for research.*

Focus

R & D Projects in

- Safety
- Heavy Haul
- High Speed
- Metro Rail
- Energy & Environment

Thank You