



Indian Railways - Driving Digital Transformation through Enterprise Architecture

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Indian Railways (IR) – size

Route length – 68,000
Km (86% electrified)

Stations – 7,300
Passenger trains –
13,500

Freight Terminals –
7,000
Freight Trains – 9,200

Locomotives – 13,000
Passenger coaches –
75,000
Freight wagons – 300,000

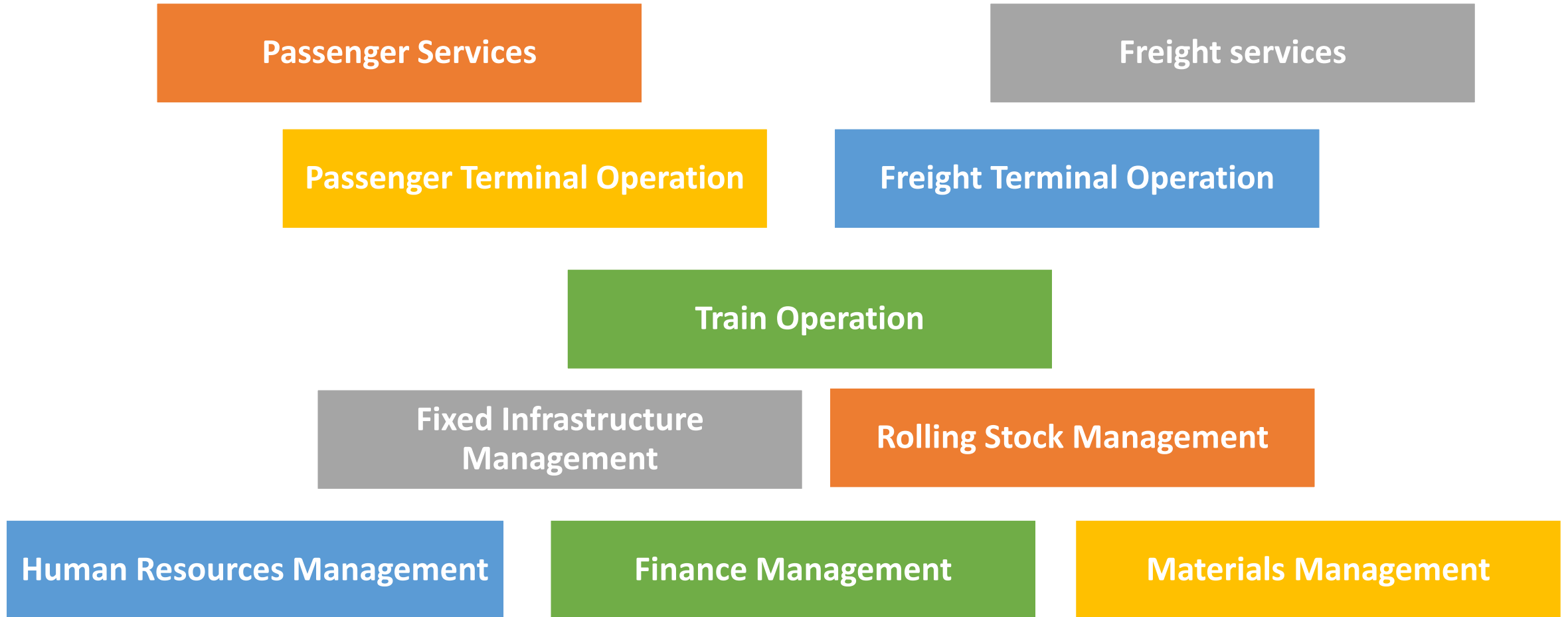
Originating
passengers – 8,500
million

Originating freight –
1,510 million tons
Lead – 600 Km

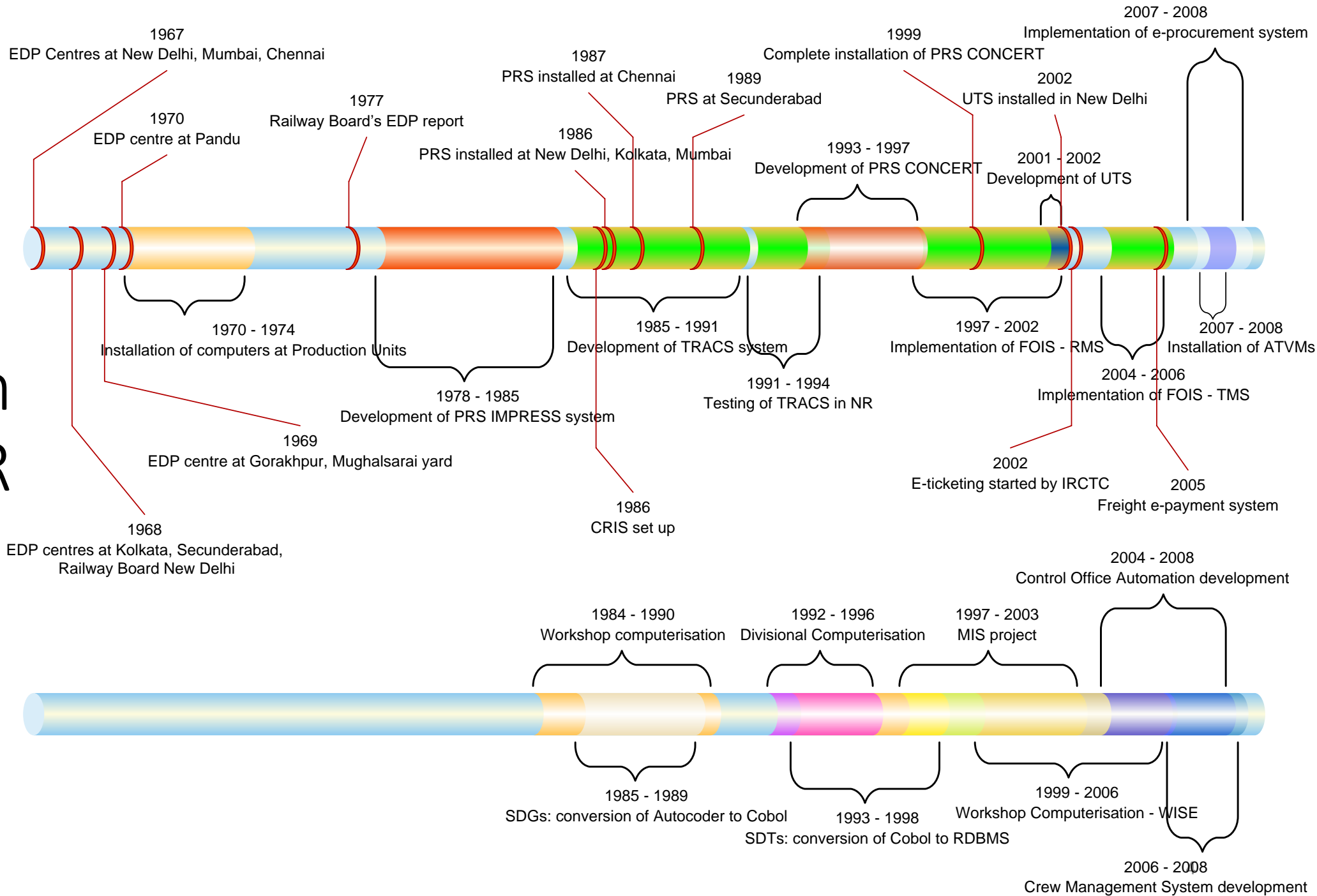
Annual Revenue – Rs.
2.2 trillion (USD 27.5
billion)

Employees – 1.2
million

Indian Railways – functional view



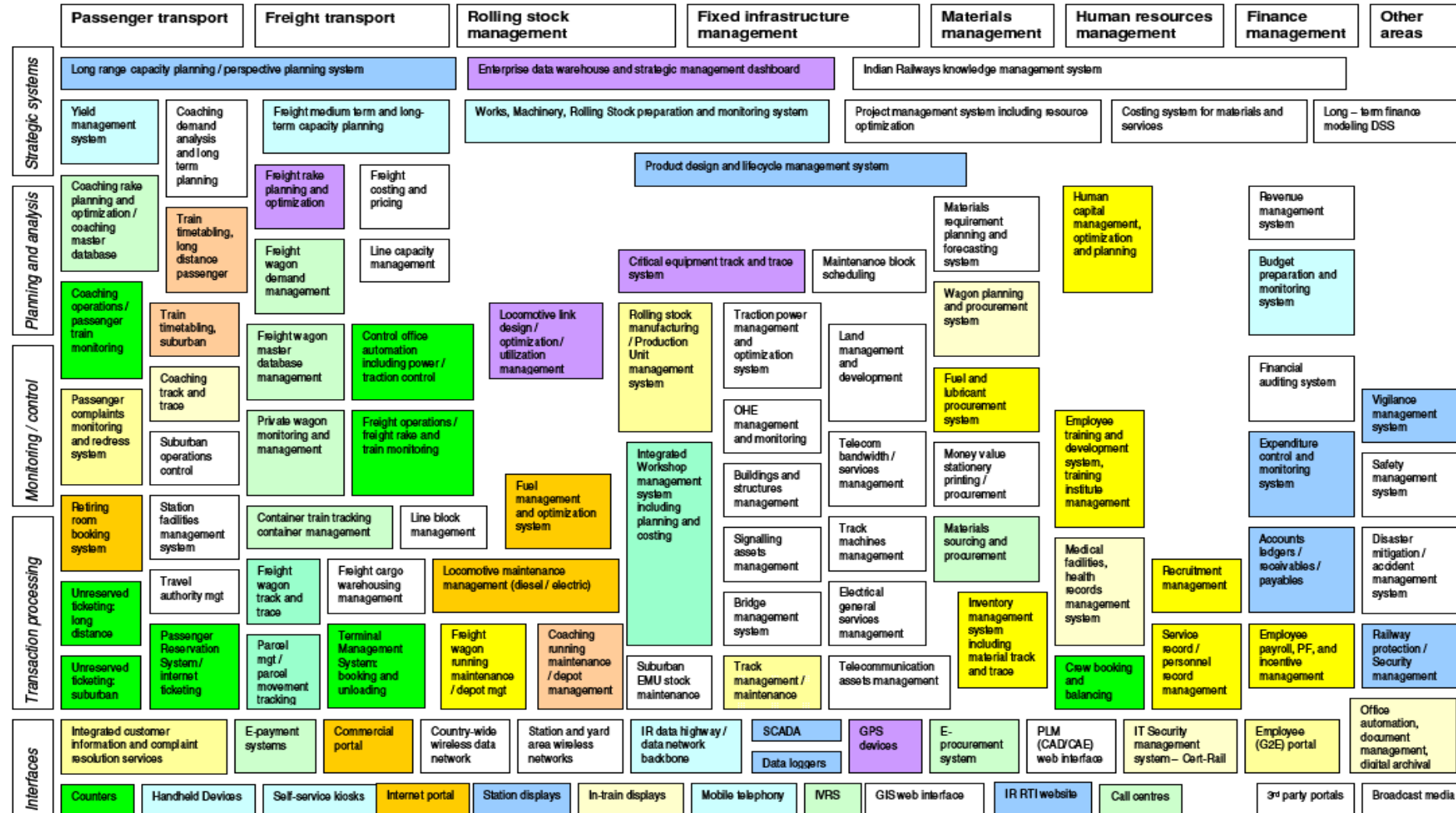
Evolution of IT in IR



IT Application Landscape of IR in 2009

Indian Railways IT Application Architecture

Centre for Railway Information Systems, Chanakyapuri, New Delhi



Box colour indicates system maturity; light yellow indicates systems at conceptual stage, through yellow and brown to green, indicates implementation stages; lavender and turquoise indicate part coverage of functionality; blue indicates systems not under CRIS purview

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IR's priorities

- **Better Passenger Experience**
 - Modern stations and high-quality on-board services
 - Higher train speeds and better punctuality
 - Safer and more secure travel

- **Bigger Freight Market Share**
 - Cheaper freight services
 - Move to higher value freight traffic
 - More widespread and convenient parcel services

- **Working with Partner Organizations**
 - Creation of the national logistics ecosystem
 - Greater private sector participation

- **Optimized Train Operations**
 - Zero-based timetable
 - Scheduled freight and parcel services

- **Better Asset Management**
 - Sensor-based diagnostics and predictive maintenance
 - Carbon-neutral technology

- **Better Financial Control**
 - Accrual based accounting and activity-based costing
 - Increasing non-fare revenues

- **Capable Employees**
 - Upgrading skills, multiskilling

Digital Transformation in IR

- Need –
 - Customer demand for IT-enabled services
 - Improved efficiency through IT-enablement of internal processes
 - Visibility across the organization for effective decision-making
 - Possibilities generated by emerging Information technologies
- Approach –
 - Integrate IT systems to provide a unified IT platform
 - Align IT with the business
 - Interchange information with logistics and travel partners through IT-enabled interfaces to develop the ecosystem
 - Harness IT advancements effectively

Limitations of business as usual

- Difficult to get an overview of IT systems and their linkages in the field
- Speed of development and enhancement is too slow
- Duplication of effort while developing different applications
- Much effort required to develop systems to interchange information with third parties
- Applications developed at the local level do not integrate well with central applications
- Software quality is highly variable and not as per need
- **No clear IT vision and roadmap – resources continually playing catch-up**

Enterprise Architecture in Govt of India

- IndEA Framework – a generic framework for development of Whole-of-Government Architecture for Ministries, State Govts, and other Government agencies
- IndEA is based on TOGAF
- Indian Railways have adopted IndEA as per the directives of the Ministry of Electronics and IT
 - The scope of IR's EA (named Vistar) covers the entire Indian Railways, except for the Railway PSUs and Autonomous bodies

IR's Complexity for EA development

- Extensive IT landscape covering a variety of business processes
 - Processes are inter-related
 - IT systems not developed cohesively
 - A redundant, divergent, and sometimes conflicting approach, due to the lack of visibility of the entire IT landscape
- Fast changing Logistics and Travel ecosystem
 - New drivers and requirements flowing in
- Quick technology advancements
 - Effective usage of technologies like Cloud, IoT, Blockchain, AI, etc.
 - Emerging areas such as Quantum Computing, VR, Metaverse, etc.

IR's Verticals – Decomposition for EA

- Freight and Parcel Business
- Passenger Business
- Train Operations
- Rolling Stock
- Fixed Infrastructure
- Material Management
- Human Resources
- Finance

VISTAR Value Proposition

Stakeholder Group	Specific Value Proposition	Basis of Value
Passenger, Freight Customers	<ul style="list-style-type: none"> • Integrated Services • Innovative Products 	<ul style="list-style-type: none"> • Interoperability within and across the ecosystem • Open Standards
Top and middle Management of IR	<ul style="list-style-type: none"> • More effective planning • Improved Performance Monitoring 	<ul style="list-style-type: none"> • Holistic view of IT landscape • Enabling of Data-driven decision making and federated planning workflows • IT Roadmap aligned with Business priorities • Customer Focused systems –Marketing strategies
Field level operations	<ul style="list-style-type: none"> • Efficient Business Operations 	<ul style="list-style-type: none"> • Boundaryless flow of Information across business verticals • Common repositories of policies/engineering designs/
Travel and Logistics Ecosystem	<ul style="list-style-type: none"> • Ease of doing business with IR 	<ul style="list-style-type: none"> • Improved exchange of data / information • Enabling of partnerships' management – Digital Interventions

Preliminary Phase

- CRIS selected by Railway Board to develop the Enterprise Architecture for IR
- CRIS defined the scope of work of the EA (named Vistar)
- EA capability created in CRIS
 - EA-certified team created
 - Consultant hired to extend EA capability
- EA awareness sessions conducted for IR stakeholders on different forums – for setting the Organizational context
- EA Principles approved by top management
- TOGAF framework tailored for IR

Approach to Architecture Development

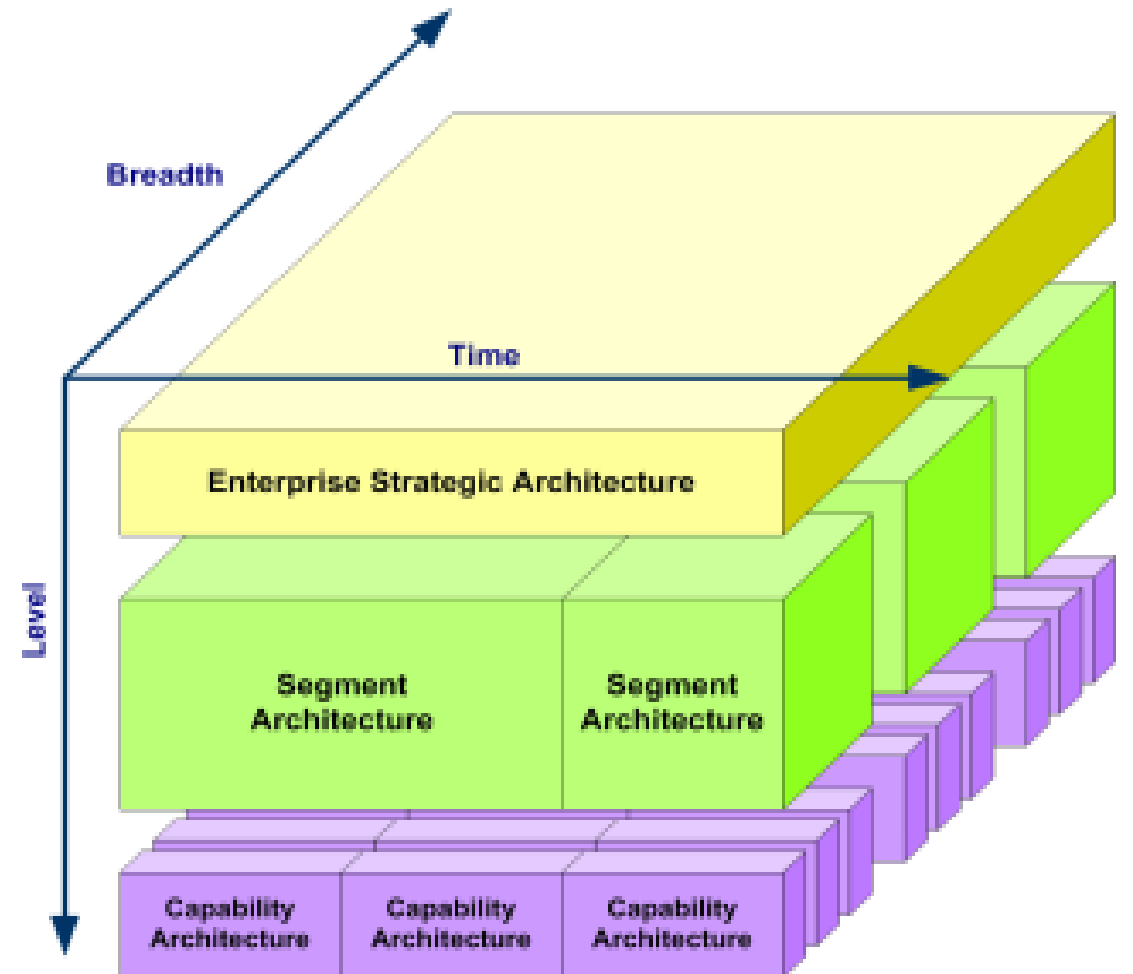
- **Target First Approach** – The baseline state of the IT systems is broadly understood and therefore, it was decided to focus on the target state first and then baseline to the extent necessary to identify changes
- **Gap analysis** - Using the traceability between IT and business functions, the IT portfolio is evaluated against business needs with focus on functionality, availability and responsiveness to determine areas where misalignment / gap exists and change needs to take place
- Business Process Gaps are also identified and highlighted to the relevant stakeholders

Architecture Landscape

- Breadth: Functionally decomposed IR into 8 business verticals
- Depth: EA study restricted to high-level processes and interactions across the verticals – Detailed BPM to be taken up in the next Phase
- Time: Planning horizon is 2030 and Vision has been developed accordingly.
- Relevance: EA Governance and Change Management Group being established to keep the architecture current

Enterprise Architecture hierarchy

- **Strategic Architectures** - show a long-term view of the entire Enterprise i.e. Indian Railways.
- **Segment Architectures** - more detailed models for areas within an Enterprise i.e. the 8 Verticals
- **Capability Architectures** - Capability Architectures are used to provide an overview of current capability, target capability, and capability increments and enable a view of the individual work packages and projects



Vision

- Developed a high-level Vision of the capabilities and business value to be delivered
- Vision based on
 - IR Vision Documents available
 - Discussions with stakeholders
 - National level directives on transportation sector
 - Other strategic level documents
- Approved by the stakeholders

Drivers – Goals – Objectives

- Enterprise Drivers – 5 enterprise-wide drivers identified
 - Growth & Sustainability
 - Enhanced User Experience
 - Efficient Business Operations
 - Safe & Secure Transportation
 - Participation in National Logistic and Travel Ecosystem
- Goals and Objectives for each of the Business Verticals aligned with the Enterprise Drivers
- High-level Target Business Architecture created

Business Architecture

- Capability based development was adopted for Business Architecture with Target First approach
- Business Services identified
- Capability heat map showed the high-level gaps with following aspects in view
 - No Gap
 - Digital Intervention required (No Automation)
 - Business Processes required to be re-engineered/new processes required
 - Enhancements in the existing application realizing the Business Services
- Capability Increments were identified

Application Architecture

- Applications were decomposed into ISS (Information System Services)
- Business Services were mapped to ISS
- Gap Analysis was done at the level of ISS
- Removed - Redundant ISSs
- Introduced - New ISSs for new Business Services
- Modifications required - in alignment with modified Business Services
- Realization diagrams created

Technology Architecture

- For Priority use cases of Freight Business a detailed analysis was performed
- Technology Architecture is being defined at the Enterprise Level in terms of
 - Reference Models – Hybrid Cloud, IoT, DevOps, Common Infrastructure, Integration
 - Standards catalog
 - Technology catalog
- This will enable the new applications/ready-for-upgrade applications to conform to the reference models and use catalogs and standards for creating the Technology layer
- The Technology Vision is to have all IR applications on open standards, cloud-enabled and future-proof.

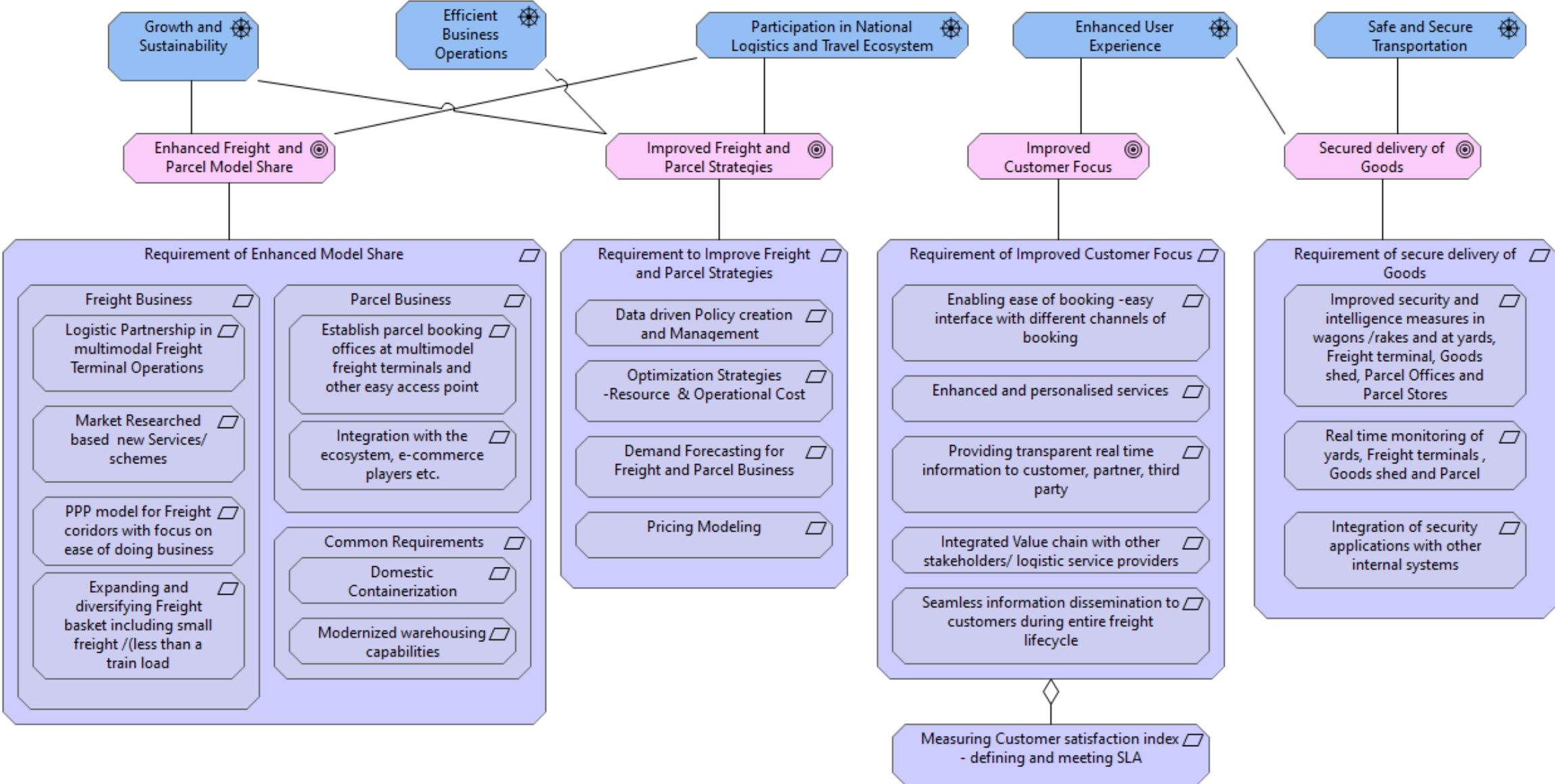
Freight and Parcel Business

Priority Business Use Case of IR

Current State of the Application – The Future is not far away..

Continuous changes happening in current applications to meet the business needs

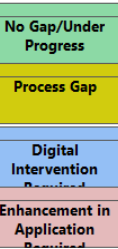
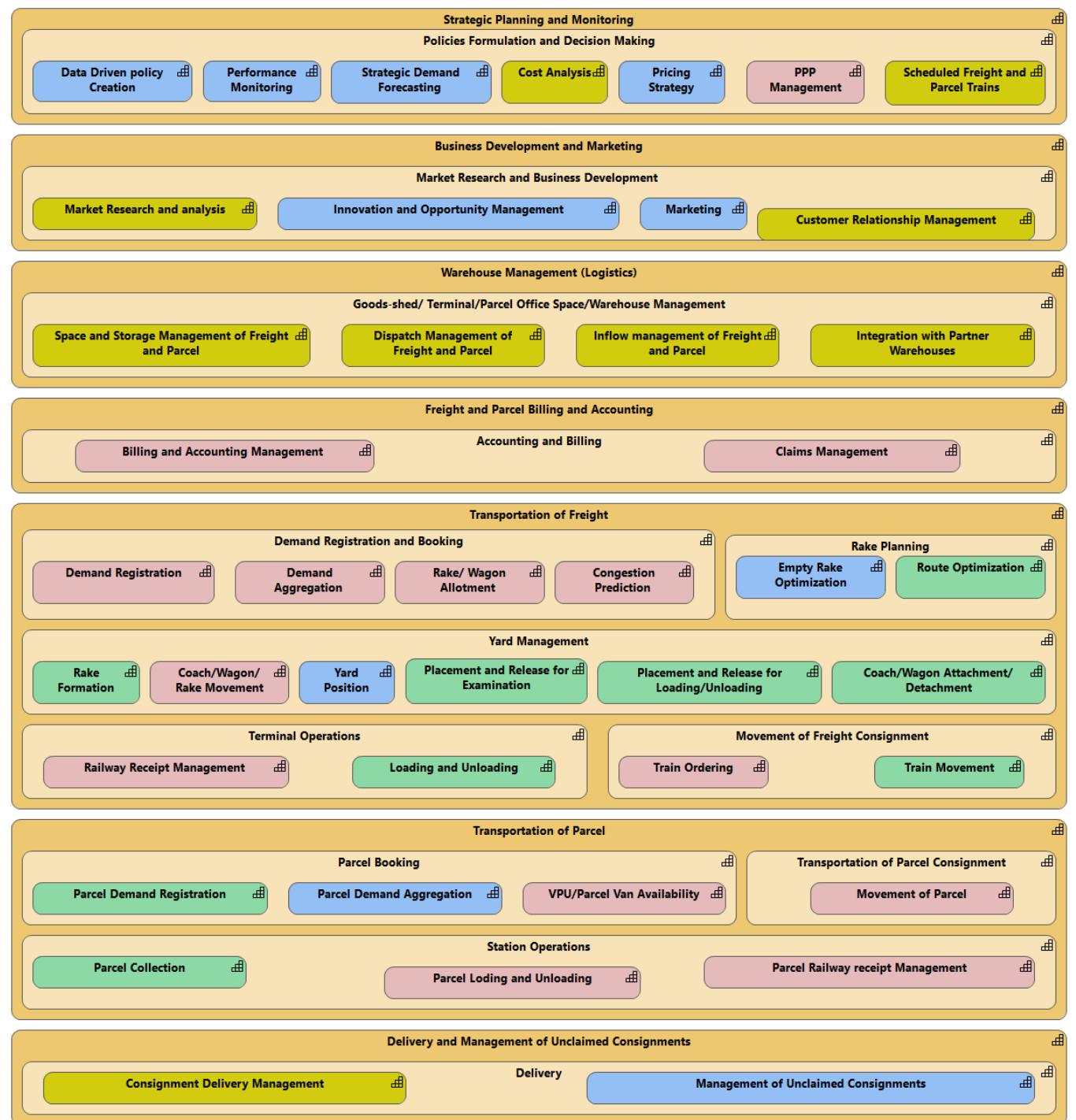
DGO – Freight and Parcel Business



Freight and Parcel Business - Target State

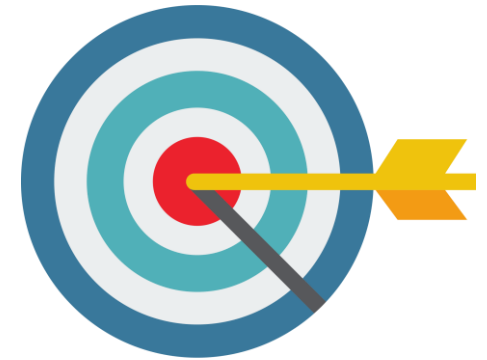
- Structured Strategic Planning towards growth and sustainability
- Market Research and Analysis, Competitive Pricing Model
- Seamless First and Last Mile Connectivity, end-to-end consignment tracking
- Booking through multiple channels / multiple operators
- Demand Aggregation to optimize resources and maximize revenue
- Integration with partner organisations – warehouse operators, 3PL organisations

Capability Heat Map



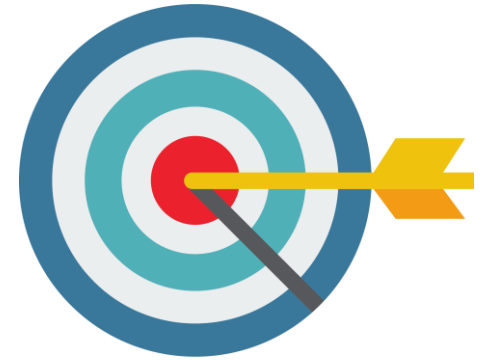
Freight and Parcel Applications – Target State

- Enabling Strategic Planning and Market Research functions - Analytics based structured policy creation and implementation
- Involving all the levels in decision making through automated systems
- Integrated Freight Traffic Solution - Connecting with external systems to get structured information – Regional manufacturing activity, sector wise pricing, PFT and ICD information flow to reduce dwell time of cargo at ports
- Customer Profiling and Segmentation – Targeted Marketing



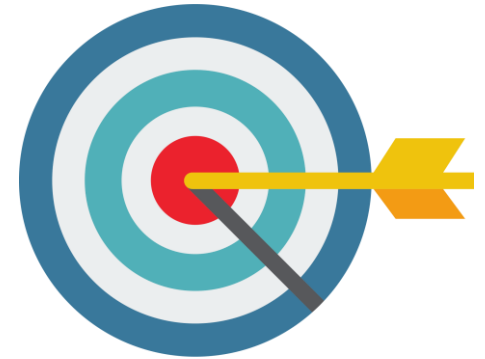
Freight and Parcel Applications – Target State

- Minimal manual intervention and automated reporting – RFID readers at locations
- Integrated with applications – no duplication or redundant functions
- IoT based maintenance alerts on wagon state to Operations for further dissemination and action
- Multiparty verification of documents across the entire freight life cycle – possible use of Blockchain



Freight and Parcel Applications – Target State

- Single click visual display of stock position – Yard, Division, Zone and IR
- Analytics based demand aggregation
- Parcel Business – multiple channels and partners, maximizing outputs, aggregation
- Integrated with Safety and Security applications for Goods and Parcel



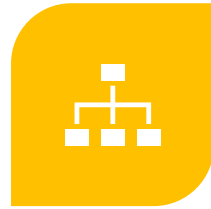
Strategic Planning – Application components



ANALYTICS BASED
DASHBOARDS



INTEGRATION
WITH EXTERNAL
AND INTERNAL
DATA-SOURCES



INVOLVEMENT OF
ALL LEVEL OF
MANAGERS



POLICY
REPOSITORY



POLICY
DISSEMINATION
AND
IMPLEMENTATION



INTEGRATED
PLANNING WITH
OTHER VERTICALS



STRATEGIC DEMAND
FORECASTING



COSTING ANALYSIS



PRICING MODEL



PARTNER
MANAGEMENT



CUSTOMER
MANAGEMENT

Application components – other areas

- Marketing and Customer Relationship
- Freight Commercial functions
- Freight Operations
- Warehouse Management
- Common Helpdesk
- Learning Management System for field users

Reports



Modern Design



Secure distribution through multiple channels



Reports with Analytical capabilities



User based adhoc reports generation capability

Target Technology Architecture

- Application should be cloud enabled
- Hybrid cloud architecture
 - Critical core modules deployed on on-premises private cloud
 - Reports, Learning Management System, other COTS based solutions, interface for external users shifted to public cloud
 - Multi-location cloud to take care of DR / business continuity
- Biometric/multi-authentication/Single-Sign-On using IDAM
 - Application with secure authentication should be accessible on Internet
- Mobile App using CRIS API gateway and following the Oauth 2.0 flows

Further Recommendations

- Data Lake to handle unstructured data also
- Business Rules Engine
- BI tools - cloud based open-source analytics for reporting
- Project Management / Application lifecycle management (ALM) tool
- Devops for Application Development

Challenges / Learnings so far

1. Stakeholders Management

- Enterprise Architecture – sanctioned as any other IT Project required Organizational context to be set first
- Stakeholders changes are frequent in IR

2. An Architecture Tool is of utmost importance

- Tool based artefacts to be used for the purpose of communication
 - The Consultants started with heavy word reports which impacted the Project timelines
- Based on approved artefacts – deliverables in the form of executive reports can be generated for stakeholders

Challenges / Learnings so far

3. IR has to develop its own EA Capability

- IR is a complex enterprise
- It is difficult and effort/time intensive for any external organization/consultant to understand the complexity and produce quality architectural deliverables
- Therefore, more effort should be put on creating IR's own stable EA capability

Thank You