Harman Intelligent Healthcare Platform

AGENDA

1. Industry Challenges & Trends
2. Intelligent Healthcare Platform
3. Reference Architecture
4. Use Cases For Providers, Insurers, Producers, Medical Devices

1 INDUSTRY CHALLENGES

CHALLENGES IN HEALTHCARE AND LIFE SCIENCES VALUE CHAIN

Healthcare and life sciences industry is fragmented, complex and highly regulated with the value chain consisting of payers, insurers, providers, producers and distributors. They generate data at an exponential rate, but do not have the ability to offer mature patient/customer centric services which requires secure collaboration, data exchange and privacy-preserving analytics.

Industry-wide challenges: Personalized services, Interoperability, Data Exchange and Collaboration, Efficiency, Intelligent Document Management, Unstructured data analytics (image, video, document, audio), Recommendation engines, Data driven decisions, Data portability, Compliance, Data Privacy, Security, Computing at the edge.

- **Insurers**: Customer 360, Personalized services, Underwriting Efficiency, Fraud Analytics, Insights into Operations, Speed to quote, Early Settlement, Recommendation engines
- **Providers**: Patient Centric services, Data driven treatment, Centralized Access to Health Records, Remote Diagnosis, Clinician satisfaction, Connected Healthcare, Remote Care, HIPAA / GDPR
- **Producers**: Remote Device Management, Connected devices, Clinical Trials, Drug development timelines, Supply Chain Management, Regulations, Counterfeits, precision medicine

KEY TRENDS

Growing Market driven by Integration of Systems

- Global EMR/ EHR market of over USD 25 billion fueled by integration of Medical devices and Digital health applications

AI and Cognitive Analytics

- Adoption of AI Models to solve a variety of Healthcare challenges

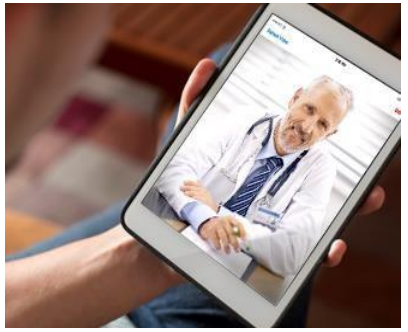
Remote Patient Monitoring

- The Global Remote Patient Monitoring Market is expected to grow at a CAGR of 17%

mHealth

- 71 % of US millennials are interested in managing health on mobile

Telehealth



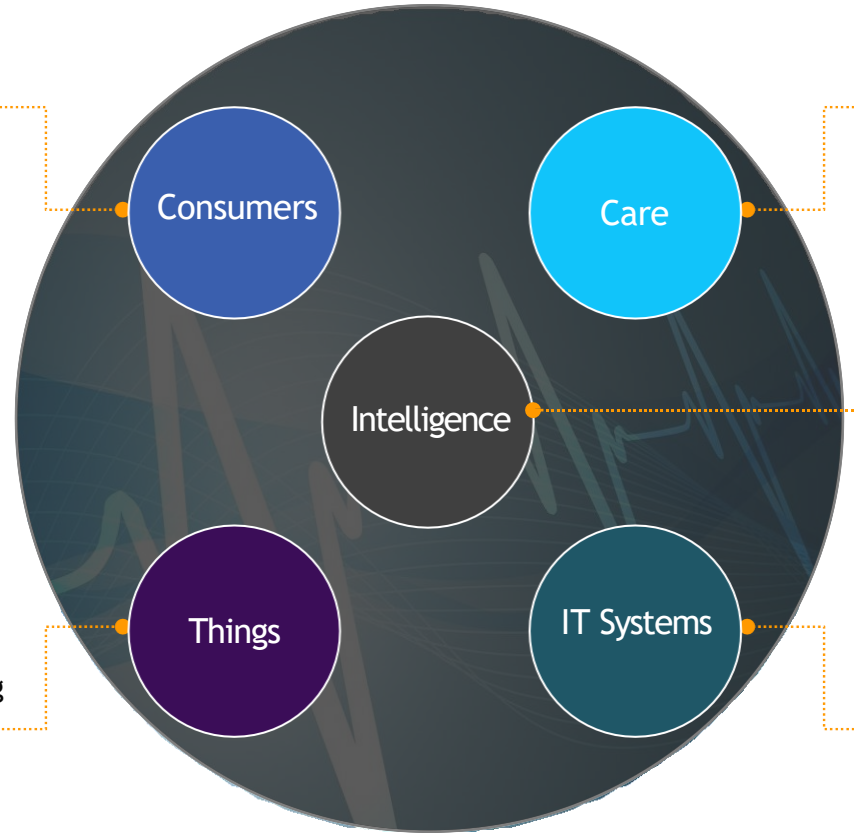
- The US Telehealth market is growing at an annual growth rate of more than 50% in last 5 years

Big Data/ Analytics

- Genomics , Population health and precision medicine continues to drive Big Data Requirements

TECHNOLOGY ADOPTION TRENDS

- E-Visits/Digital Clinical Encounters
- Online Consumer Health Education, Advice
- Patient Portal
- CRM



- Virtual Care and Collaboration Platforms
- Digital Imaging

- Population Health Management
- Precision Medicine
- Clinical and operational Analytics

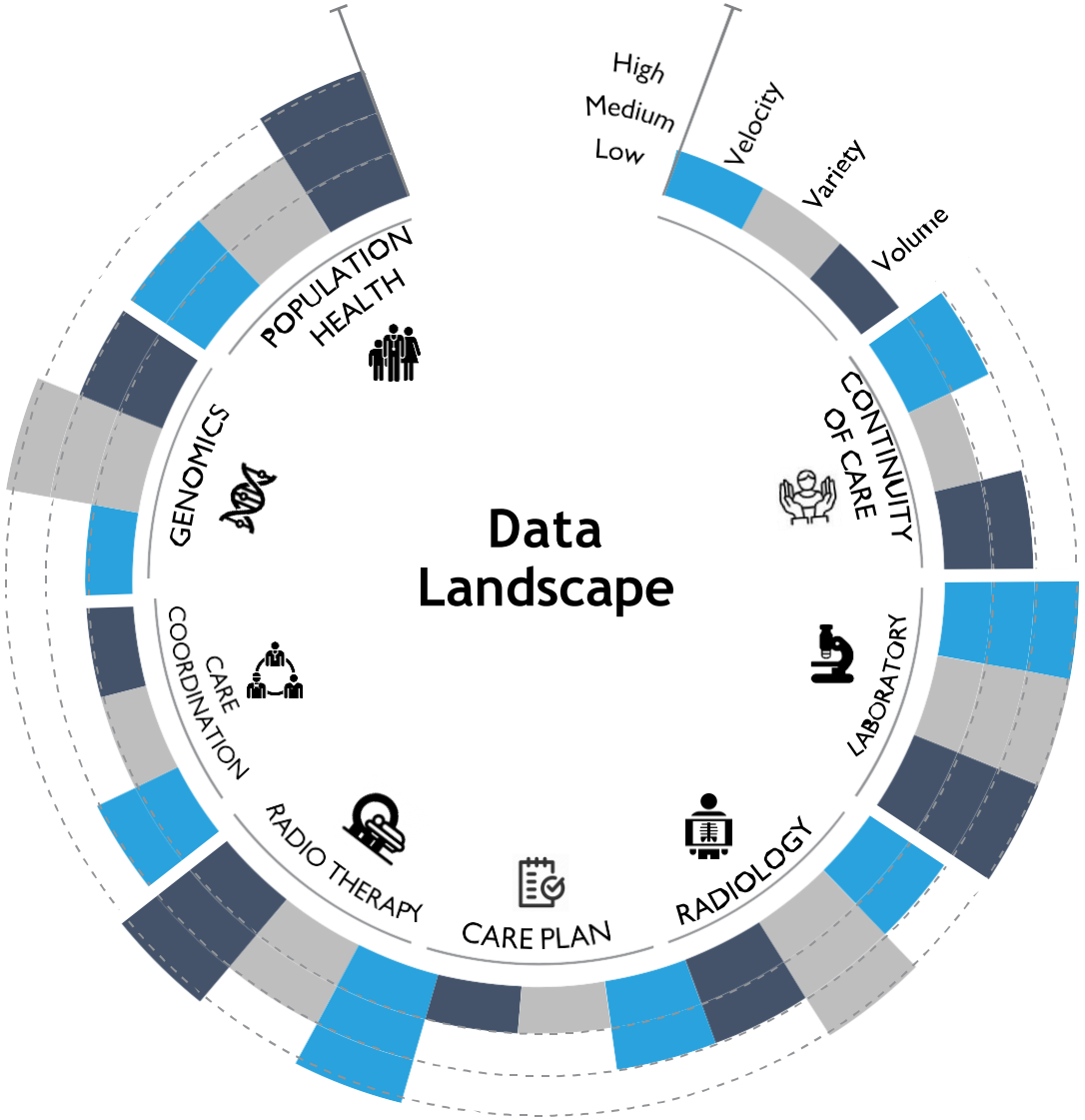
- Patient Wearables
- Remote Patient Monitoring
- "Real- Time Health System"
- Wellness Analytics

- EHR
- PACS/ RIS
- LIMS
- EDW/ Big data platform

Source: Gartner

- Healthcare Companies are building **connected systems** strategy to generate single view of patient on single integrated data platform
- Need to shift batch processing of healthcare data to **Real time** to provide decision support at the Point of care
- **Adoption of AI** to flag priority of pathology test to advance Cancer care treatment
- **Wearable sensors** are powering real-time data collection to run AI algorithms for Personalized care and monitor patients in Homecare and palliative settings.
- **Securing healthcare data in cloud** – Adoption of the cloud security features like Bring Your Own Key (BYOK) and Key Vault to securely store the certificates and other credentials in cloud.
- **Deep learning Models** to flag anomaly in the data even before it is ingested to improve data quality.
- In addition to clinical trials, **Genomic data** is also getting leveraged to build research community portal for diseases such as Cancer, ALS

DATA, ANALYTICS & PLATFORM BUSINESS



Cancer Screening & Diagnosis

Analyzing MR images using different DL techniques we can detect any abnormalities, characterization of a suspected lesion by defining its shape, stage of disease & determination of prognosis or response to treatment over time during monitoring

Dose Prediction

Using ML/DL techniques on already Treated patients historical data to find similar patients to find optimal treatment planning for the newly admitted patients which improves clinical outcome & care team effectiveness

Genomic Characterization of Tumors

AI methods can also be used to identify specific gene mutations from tumor pathology images instead of using traditional genomic sequencing

Patient Risk Analysis

Patients treatment, Demographic data can help analyze patients hospitalization risk by assigning risk scores & prioritizing care planning

Quality of care measurements

Linking databases on patient outcomes with data on patient characteristics & treatment can offer unprecedented potential for feeding back quality an efficacy of care.

2

INTELLIGENT HEALTHCARE PLATFORM

HARMAN INTELLIGENT HEALTHCARE PLATFORM

Harman Intelligent Healthcare Platform is designed to help healthcare and life sciences enterprises in their journey towards customer centric services by seamlessly transforming their data, analytics, intelligence and governance functions in a secure, cost effective and privacy preserving manner.

It is powered by Azure Health Cloud

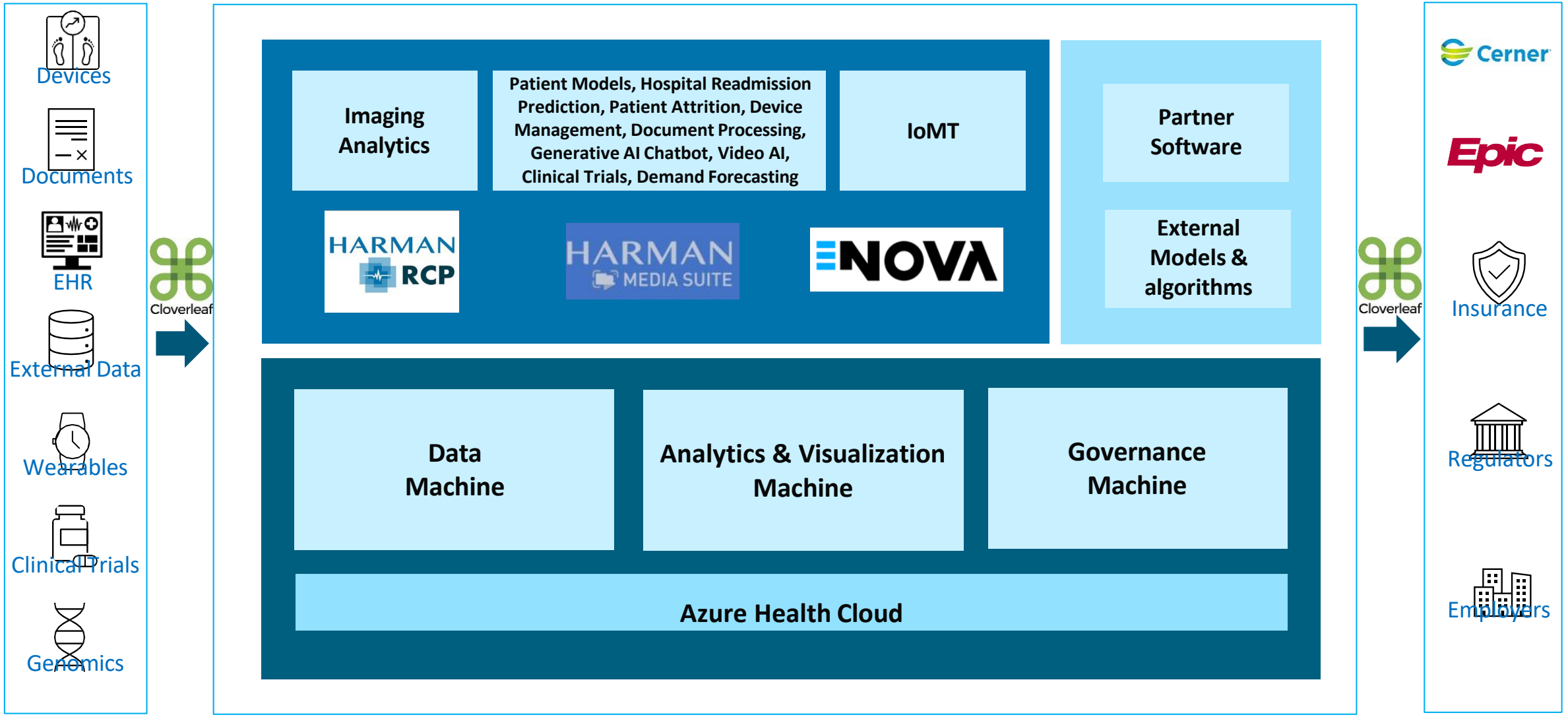
The Platform is developed using Harman's patented IP, Azure services and best in class Commercial and Open-source technologies.

KEY TRENDS DRIVING PLATFORM ADOPTION IN HEALTH CARE

(https://mitsloan.mit.edu/ideas-made-to-matter/4-trends-driving-platform-adoption-health-care)

The Flywheel Effect	Push for value-based care, the federal mandate for interoperability, and the expansion of virtual and home-based care models trigger the need for platform capabilities, including data sharing, care coordination, shared workflows, and analytics.	The impact is heightened when the incentives among platform participants are aligned, Susan Woods, M.D., founder and CEO of remote patient monitoring firm Generated Health. "It's not just about what the patients want, but also what the clinicians want," Woods said. With a platform in place, it's easier for a physician to recommend a nutritionist (or a vetted and approved nutrition app) to any patient who asks.
Increased investment in digital health	Investors poured $29 billion into digital health initiatives in 2021, according to consultancy and venture fund Rock Health. Platforms account for about 40% of this investment.	Adam Grossman, partner at investment firm Deerfield Management, sees these platforms emerging in many parts of the health care ecosystem where matching has typically been difficult: Finding staff to cover a shift, finding doctors with appointments available, finding patients for clinical trials, and so on.
New Data Models	Adoption of Fast Healthcare Interoperability Resources, a standard for data exchange that uses application programming interfaces to enable systems built by different vendors to share information.	Every health care organization should be thinking of itself as a digital platform. If you're required to use APIs, that effectively makes you a platform." Dr. Randall Williams, Digital Care Advisors. This shift in data access and availability enables health systems to get a more complete view of their patients as well as obtain and integrate data from external sources. "It's an enormous opportunity for using the right kind of machine learning tools to learn from messy data sets." Suchi Saria, Ph.D., founder and CEO of AI platform Bayesian Health.
A more competitive landscape	Platforms put a range of virtual, in-home, and in-person options into the patient's hands.	This can be valuable for people managing chronic conditions. Bobby Sepucha, CEO of Cricket Health. Patients benefit from a care experience that's less transactional and more ongoing. As patients use the digital platform to keep track of vital signs, start a new medication or treatment, and make diet and lifestyle changes, they benefit from interacting with a provider every few days.

HARMAN INTELLIGENT HEALTHCARE PLATFORM



KEY COMPONENTS OF THE INTELLIGENT HEALTHCARE PLATFORM

- **Data Machine**
  - Scalable, reliable and comprehensive engine to support various data types.
  - Data Machine ingests, processes and securely stores data from devices, sensors, clinical, genomic, patients, claims, wellness etc.
  - Process batch or real time streaming data from various sources including formats such as EMR, FHIR/HL7.
  - Process structured, unstructured, semi-structured and graph data with validation rules to ensure accuracy, quality and logical consistency.
- **Analytics & Visualization Machine**
  - The data lake stores various data types at scale and helps run exploratory and predictive analytics and visualizations to generate actionable insights.
  - Centralised reporting and analytics portal to meet all various requirements including Self Service BI option for power users.
- **Intelligence Machine**
  - The Intelligence Machine comprises of Machine Learning and Deep Learning algorithms and models across areas such as Predictive Analytics, Computer Vision, NLP and Graph analytics.
  - The Intelligence Machine also comes with pre-built software products such as Harman Remote Care Platform as well as Harman Intelligent Device Management Platform.
- **Governance Machine**
  - In partnership with Azure, we provide access to more than 130 HIPAA eligible services as well as numerous certifications for industry-relevant global IT and compliance standards, including support for GDPR, HITRUST, ENS High, HDS, and C5.

KEY ARCHITECTURE PRINCIPLES OF THE PLATFORM

HARMAN
A SAMSUNG COMPANY

Compliance & Convergence

- Cater to HIPPA regulatory Compliance around data storage and access
- Converge towards the future architecture with data retention, Archival, and data lineage

Cloud First

- Secure, Elastic, Fault tolerant, responsive and highly scalable cloud native solution
- Adopt serverless technologies

Service Quality

- Preventive and proactive monitoring of Data and analytics platform to avoid disruption of services for end users

Adaptable & Flexible

- Data platform to provide flexibility to quickly add new data sources
- Data Platform to support real-time, near real-time, batch, on-demand and event driven data services

Loosely Coupled Services

- Abstraction layer for data access through common API patterns, micro services

Multi-Tenancy

- Single instance to serve all customers/tenants, there by ensuring security
- maintain a shared infrastructure for all customers

Information is treated as an Asset

- Robust Data governance
- Controls in place for Data dictionaries, Data models, data stewardship
- Compliance to manage information, confidentiality. Integrity and availability

Re-use before Buy before Build

- Reuse existing tools, data management assets, Data pipelines, Data Quality principles
- Design for reusability

Control Technical Diversity

- Manage technical debt through highly adaptable architecture Components and best practices to implement new changes quickly

Security by Design

- Data-at-Rest (encryption)
- Data-in-motion (SASL/SSL/TLS)
- RBAC
- Data anonymization

Privacy by Design

- HIPAA and HITECH
- Adherence to data privacy Compliance (GDPR)
- Archiving and data retention policies

Open Standards & Open Source Software

- Open Standards for Seamless Interoperability and data interface with third party systems
- Rationalisation of Commercial Software against Open Source

KEY VALUE PROPOSITIONS OF THE PLATFORM

PATIENT CENTRICITY

- Patient Centric Analyses
- Data driven treatment management
- Proactive patient engagement
- Real-time monitoring
- Improved health conditions

DATA DRIVEN DECISIONS

- Detect anomalies
- Predict future states
- Identify root causes to support rapid decision making
- Patient & Care Analytics
- AI-based risk profiling
- Improved Data Quality
- Streamlined data pipelines

ACCELERATE INNOVATION

- Digital Experiences
- Mobility solutions for health and wellness
- Shorten the journey from Unstructured to Structured data
- Robust Platform capable of meeting current future business requirements

BUSINESS AGILITY

- Transformation
- Flexibility in operations through simplified payment & claims
- Faster decisions from Unstructured data
- Improved collaboration
- Automation of IT architectures

According to a BCC report, the worldwide healthcare cloud computing market is poised to hit $35 billion by the year 2022, with an annual growth rate of 11.6%.

HEALTHCARE VALUE CHAIN & KEY APPLICATIONS

	PAYERS, INSURERS		PROVIDERS		PRODUCERS	
	Payers	**Insurers**				
Key Actors	• Government (Medicare, Medicaid) • Employers • Individuals	• Insurers • Managed Care • Pharmacy Benefit Managers	• Hospital Systems • Physicians • Clinics • Nursing Homes	• Pharmacies • Home Health	• Pharmaceuticals • Biologics • Devices • Suppliers	• Contract Research Organisations • Wholesalers • Distributors
Market Size	• Global IT spending in insurance grew by 5.2% in 2021 to reach $210 Billion. • Forecast to grow at a CAGR of 6.4% to $271 billion in 2025.		• Global IT spending grew by 7.9% in 2021 to $128 Billion. • AI, RPA, digital workplace and cloud are key priorities.		• Data to be added	

Key Applications

Data Machine: Data discovery, Data ingestion and transformation, ETL, data integration, Cleansing and enrichment, Master data management, Metadata management, Data cataloging, Data quality assurance, Data migration, Unstructured data processing

Analytics & Visualization Machine: Data Lake, Dashboarding/reporting, Self-serve BI, Mobile BI, Collaborative BI, Descriptive analytics, Revenue Management, Clinical Research Management

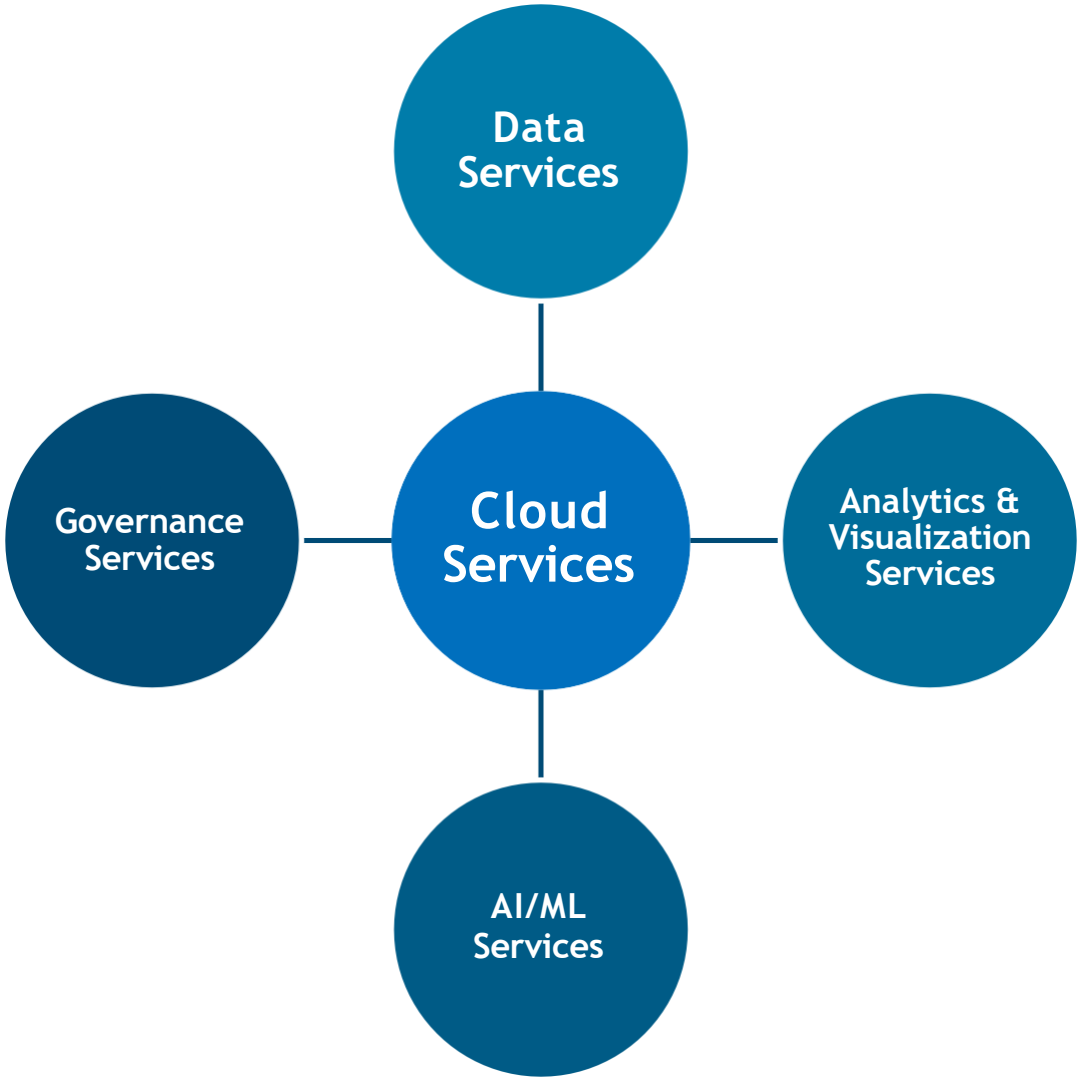
Intelligence Machine: Value based care & Patient Centric Analyses, Data driven treatment management, Cognitive services (NLP/NLG, AR/VR, computer vision, Image, Text, Video analytics), Cybersecurity, Intelligent Document Processing, Unstructured data processing, Insurance Fraud Analytics, Cybersecurity, Predictive and prescriptive analytics, Recommendation engines, Device Health Analytics etc.

Governance Machine: Data profiling, Data Encryption and Masking, Compliance, Validation and Auditing, Data Vulnerability and Risk Assessment

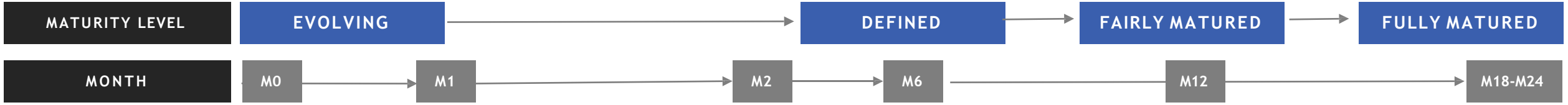
KEY SERVICE OFFERINGS WHICH CAN BE BUNDLED WITH THE PLATFORM

- **Cloud Services**
  - Migration to Azure Health Cloud, Harman Intelligent Healthcare Platform Implementation,

  Platform Run, Data Migration, Cloud Management, Application Migration such as Clinical applications, EHRs, pharmacy, Pa\tient management, Claims Management, Revenue Management, Clinical Research Management
- **Data Services**
  - Data discovery, Data ingestion and transformation, ETL, data integration, Cleansing and enrichment, Master data management, Metadata management, Data cataloging, Data quality assurance, Data migration, Unstructured data processing
- **Analytics & Visualization Services**
  - Data Lake, Dashboarding/reporting, Self-serve BI, Mobile BI, Collaborative BI, Descriptive analytics,
- **AI/ML Services**
  - Patient Centric Analyses, Data driven treatment management, Cognitive services (NLP/NLG, AR/VR, computer vision, Image, Text, Video analytics), Cybersecurity, Intelligent Document Processing, Unstructured data processing, Insurance Fraud Analytics, Cybersecurity, Predictive and prescriptive analytics, Recommendation engines, Device Health Analytics,
- **Governance Services**
  - Data profiling, Data Encryption and Masking, Compliance, Validation and Auditing, Data Vulnerability and Risk Assessment



ROADMAP TO TRANSITION TO INTELLIGENT HEALTHCARE PLATFORM



HEALTHCARE PLATFORM TRANSFORMATION JOURNEY

Discovery, Business Model Assessment

- Business & Organization Assessment
- Future State Vision for Information Management
- Assets Analysis & Classification
- Data, Analytics, AI/ML Management Strategy
- Current State Architecture Assessment
- Future State Architecture vision
- Prioritized Roadmap
- High Level Capability Requirements

Design and Planning

- Design Solution Architecture
- Design Data Architecture
- Define Data Governance Model
- Review and Update Data models
- Define integration, data, platform, report, analytics, AI/ML requirements
- Define Project Plan
- Define Project Team
- Identify risk and dependencies
- Environment setup

Platform Implementation

- Development of missing Interfaces
- Development of Data lake
- Development Physical Data Models
- Data validation, transformation, quality check and enrichment
- Development of reporting DataMart
- Report Development
- Development of self-service BI framework
- Deployment of Reports
- Implement Data Governance processes

Insights Driven Decisions, AI/ML & Advanced Analytics

- Development of Analytics Base Tables
- Use Case Definition
- Model Development ,Validation and Hyperparameter Tuning
- Validation of end to end data, reporting and analytics pipeline
- Deployment of Interfaces
- Deployment of AI/ML, Advanced Analytics Models
- Devices and ancillary data sources on-boarded to platform

Continuous Improvement

- MLOps for model pipelines
- Model Hub
- Crowdsourcing of models
- Continuous Model pipeline
- Improving KPIs

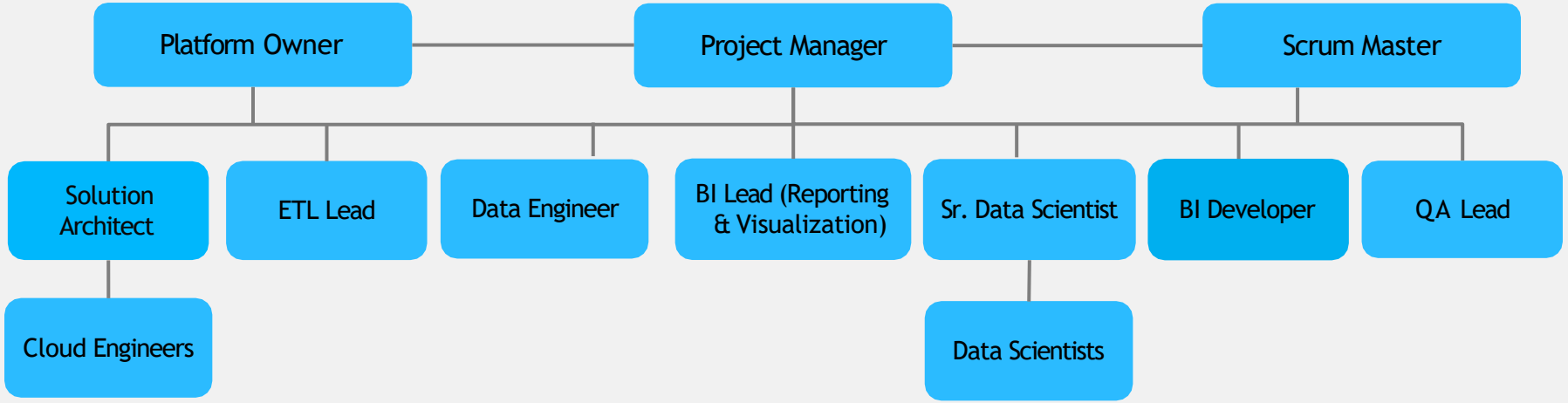
PROPOSED OPERATING MODEL

HARMAN INTELLIGENT HEALTHCARE PLATFORM

Core Team

- Healthcare SME
- Cloud Architect
- DevOps Engineer
- Data Architect
- Data Custodian
- Compliance Lead
- UI Designer
- Chief Data Scientist
- QA Architect
- ML Engineer

Project/Scrum Team



Key Points

- Build with a right shore strategy
- Deploy on Azure
- Scrum master(s) will work across workstreams
- Agile based development approach
- Shared teams can work across multiple workstreams

4 USE CASES FOR PROVIDERS

CASE STUDY: HOSPITAL READMISSION PREDICTION

BENEFITS

- Predicted Readmission With 82% Accuracy
- 350% Lift In Outcomes

CUSTOMER

One of the major health care Service providers. The client wanted to develop a model to predict likelihood of readmission and develop guidelines on measures to lower readmission rates.

SOLUTION

- Built a Predictive Analysis model with 82% accuracy to generate readmission risk score and factors causing it.
- Analyzed inpatient data with over 50+ variables and calculated patient level risk scores.
- Identified different readmission rates and areas by diagnosis, LOS, demography
- In addition to CHF, COPD, Pneumonia and Hip transplant provided insights on other diagnosis such as AMI and HAC (focus on Iatrogenic pneumonia and UTI) and this differentiates Harman readmission model
- Identified top causes of readmissions by a variety of factors including medical history, disease category, demographic profile.
- Proactively analyzed hospital acquired conditions (HAC) and studied discharge disposition to highlight discharge to SNF (skilled Nursing facility) as key factor to hospital readmission
- Algorithms: Logistic Regression, Trend Analysis

CASE STUDY: PATIENT ATTRITION PREDICTION

CUSTOMER

Leading provider of in-center and at-home dialysis services wanted to develop a model to decrease patient attrition and increase the revenue

SOLUTION

- Built risk models for potential hospitalization, expiration and transfers to other facilities outside client's dialysis centers within the next 30 days.
- Highlighted factors such as vitals, observations and patient behaviors (e.g. adherence, absence etc. from dialysis) that led to hospitalization.
- Demonstrated models for hospitalization, expiration and transfers for 1-month, 3-months and 6-months time frame
- Built dashboards to visualize risk distribution and current hospitalization, expiration and transfer rates
- Algorithm: Logistic Regression Model

BENEFITS

- 80% Accurate Insights On Patient Hospitalization
- 70% Accurate Prediction Of Patient Transfer & Expiry

HARMAN
A SAMSUNG COMPANY

THANK YOU