



Precision Medicine for Health Systems

Enabling the Transformation of Healthcare Systems

November 14th, 2016



Key Messages

1. A variety of data types are needed to enable precision medicine
2. These data types include:
 - a. Clinical data
 - b. Lab and genomics data
 - c. Imaging data
 - d. Sensor data
 - e. Patient reported data
3. The amount and size of these data sets will require them to be collected in a cloud computing environment
4. Hospital systems need a well thought out, systematic approach to developing the infrastructure to collect and analyze this data
5. If done properly, this comprehensive data set can be used to drive insights and better clinical outcomes and improve drug development through both traditional analytics and machine learning

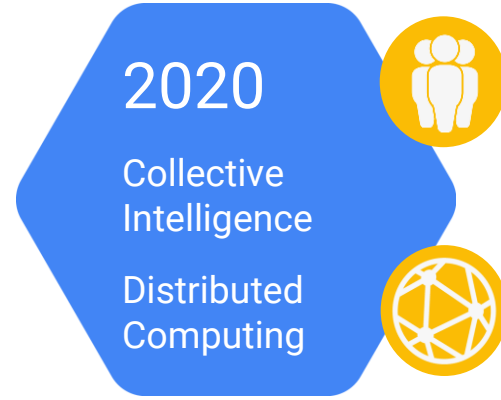
Enterprises are experiencing a Digital Transformation



Data on premise, hard to access, analyze and use

Productivity tools built for individual, local usage

IT focusing on **where** it computes



Data stored in cloud, simple to query

Machine learning drives deep, actionable insights

Collaborative, cloud based productivity applications

IT changing **how** it computes.

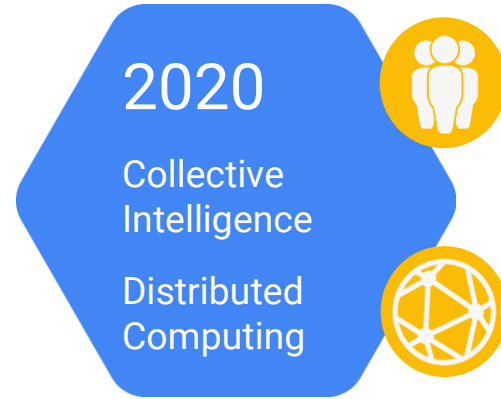
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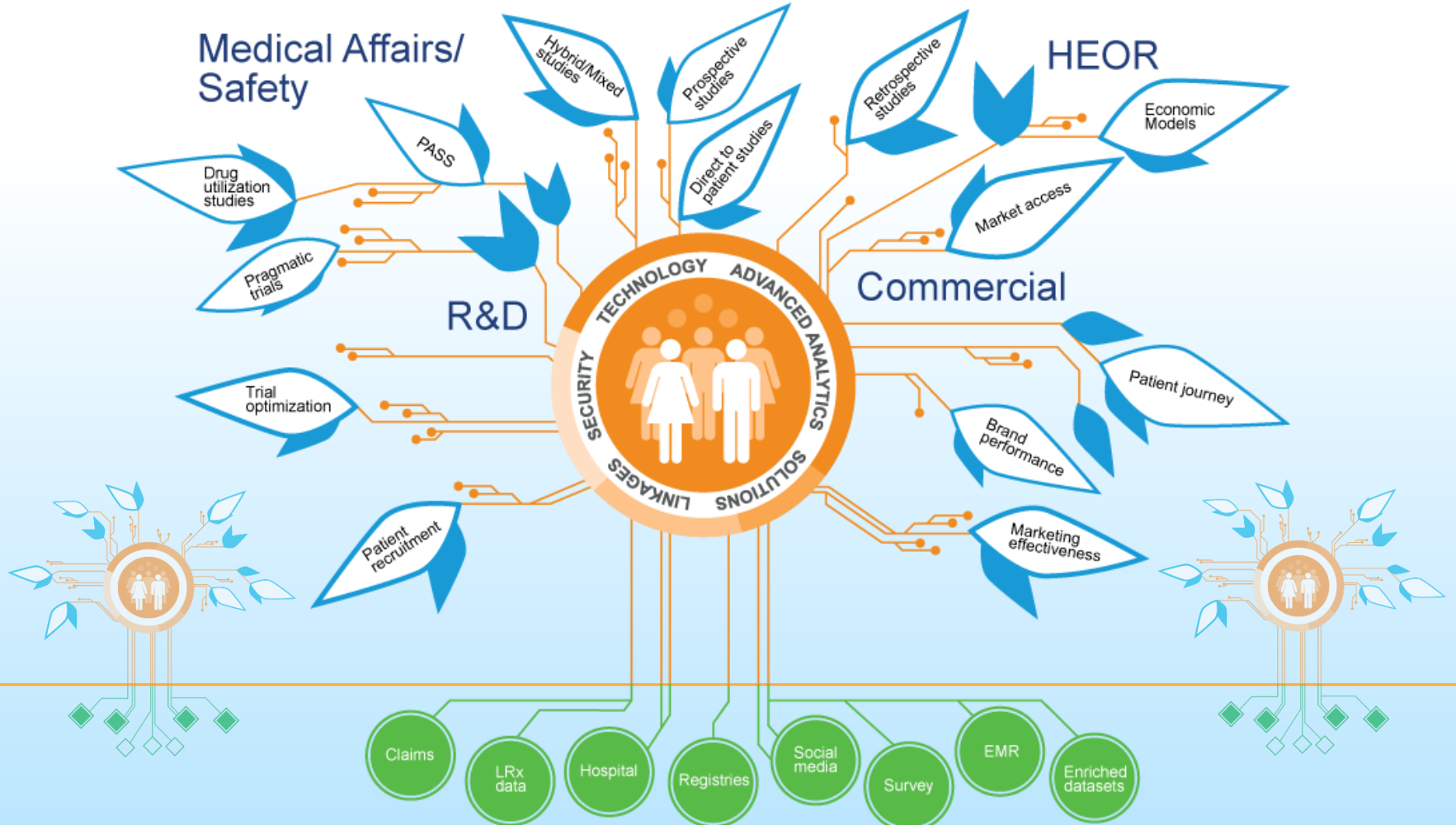
Data stored in cloud, simple to query

Machine learning drives deep, actionable insights

Collaborative, cloud based productivity applications

IT changing **how** it computes.

The same data and technology can be used for both clinical research and patient care



Creating the Infrastructure to Support Precision Medicine

Sources

Settings

Data Processing / Google Cloud Based Platform

Solutions & Apps



Epic and Cerner Health Records



Imaging Systems



Lab and Genomic Data



Sensor and PRO data



Community Based Care



Acute Care



Port-Acute Care



Ambulatory Surgery Center



Patients

IMAGING



SENSORS



MOLECULAR



SELF-REPORTED DATA



CLINICAL



coreGPS

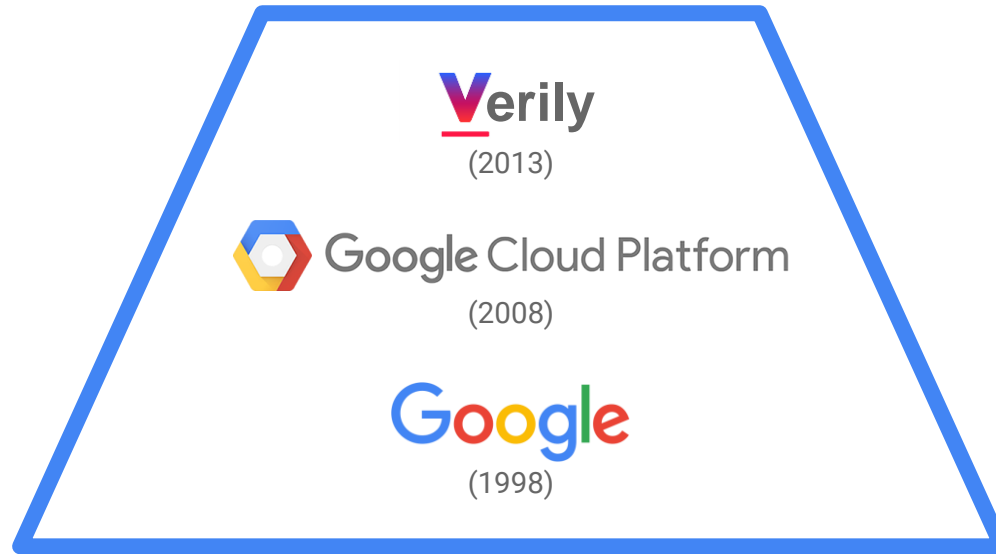


Google Cloud Platform



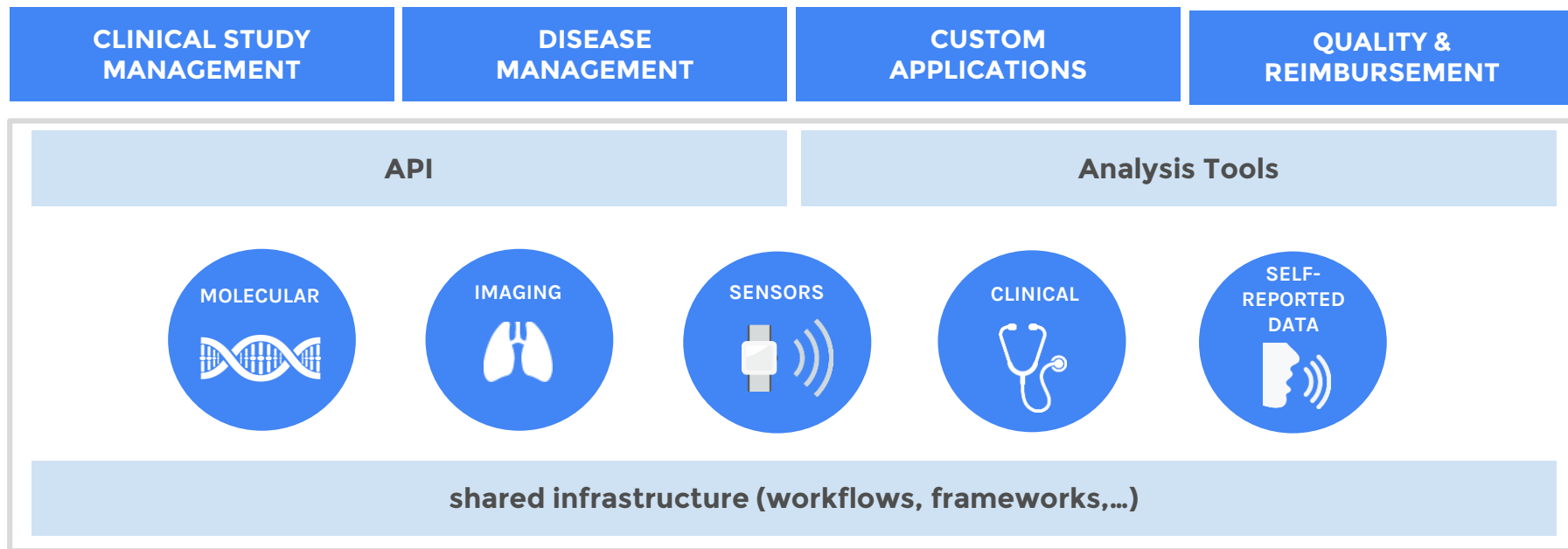
Healthcare Capabilities

Standing on the shoulders of the Web

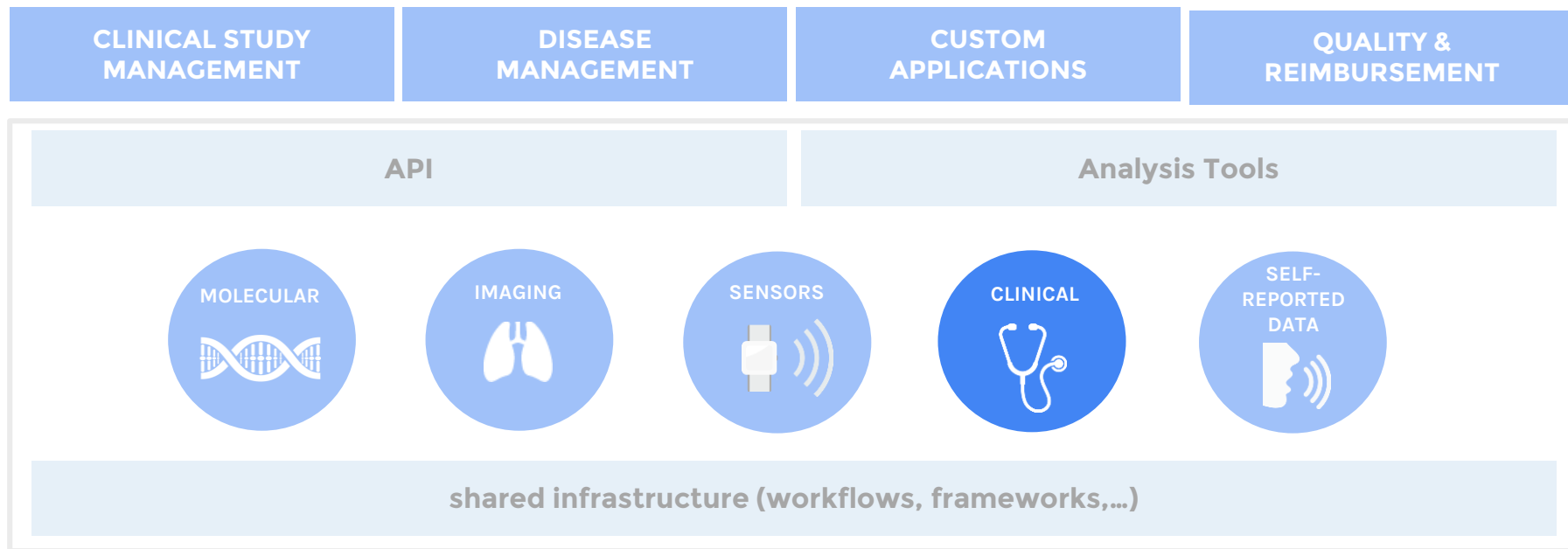


*Building on Google's core infrastructure,
data analytics, and machine learning.*

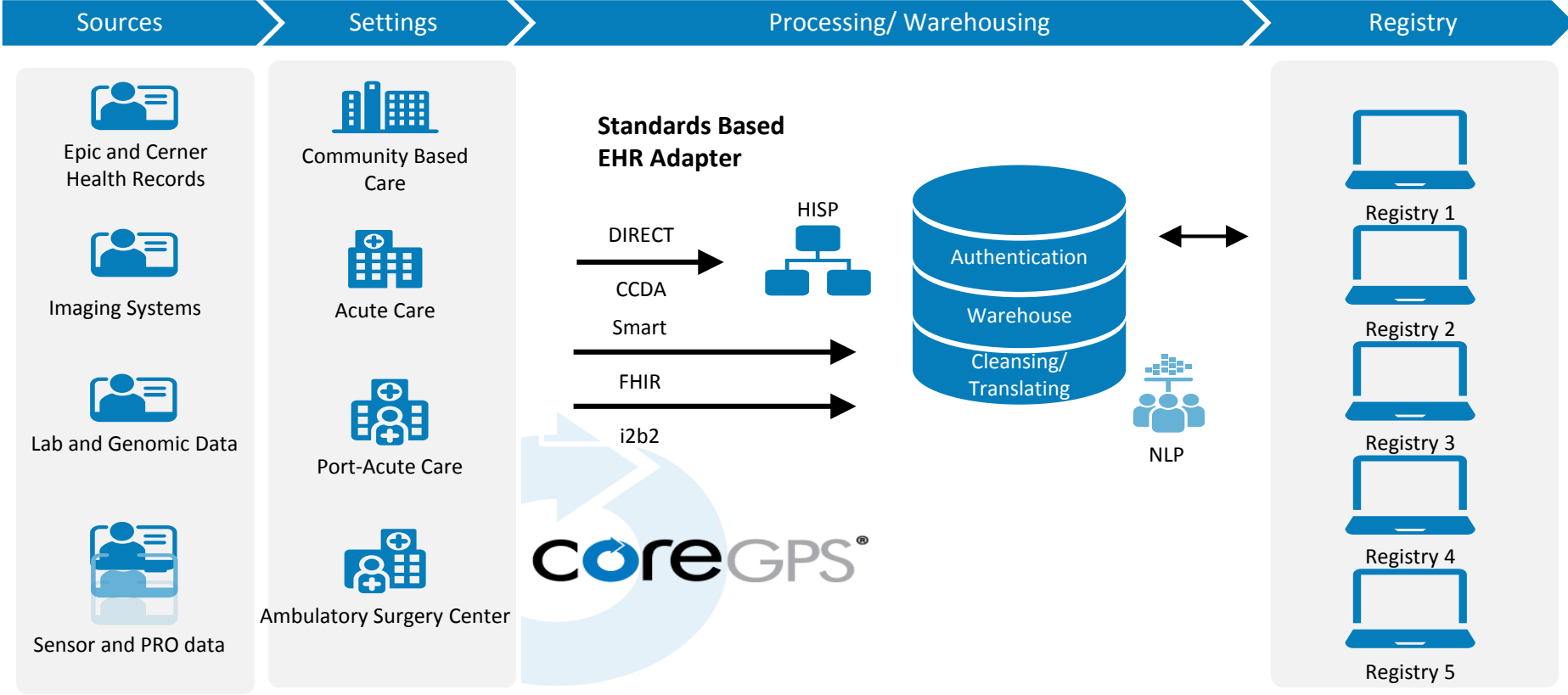
Platform Vision



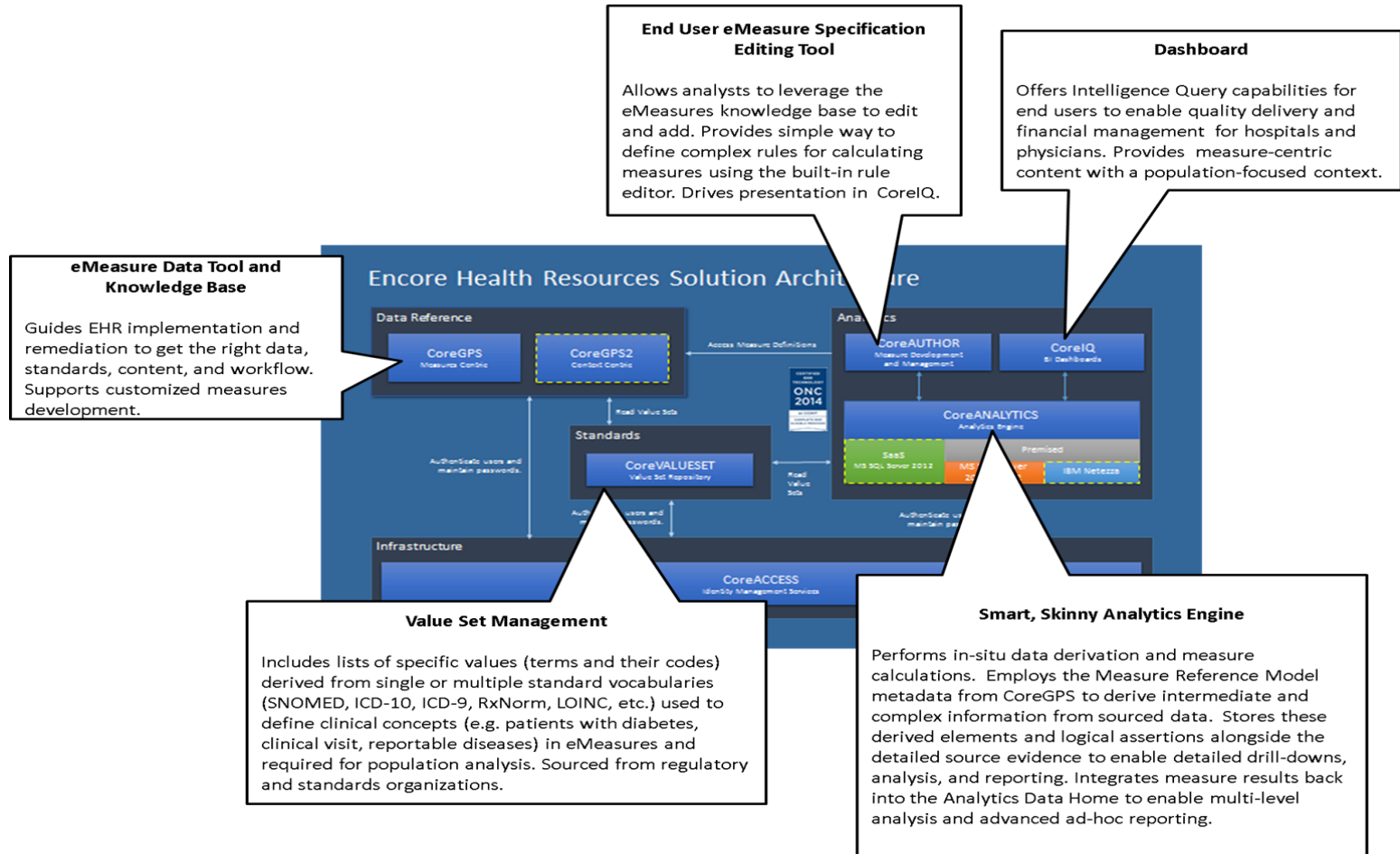
Clinical Capabilities



Mapping Clinical Data



Getting Data Mapping Right - Core Suite Tools



Getting Data Mapping Right - Risk Assessment Process

Risk Assessment Score Report

Source Content from CMS					Detailed Content from Risk Assessment									
Program	Version	Measure Category	Measure Name	Measure Description	Risk Priority Code	Risk Priority Sequence	Functionality / Certification	Workflow	Adoption	Content	Data	Reporting	Total	
EH MU Stage 1	Not Applicable	CQM - EH	ED-1 Subset-1	Emergency Department Throughput – Median Time from ED Arrival to ED Departure for Admitted Patients	Not Prioritized	1	0.6	0	1.2	0.3	0.6	0.9	3.6	
EH MU Stage 1	Not Applicable	CQM - EH	ED-1 Subset-2	Emergency Department Throughput – Median Time from ED Arrival to ED Departure for Admitted Patients	Not Prioritized		0	0	0	0	0	0	0	
EH MU Stage 1	Not Applicable	CQM - EH	ED-1 Subset-3	Emergency Department Throughput – Median Time from ED Arrival to ED Departure for Admitted Patients	Not Prioritized		0	0	0	0	0	0	0	
EH MU Stage 1	Not Applicable	CQM - EH	ED-2 Subset-1	Emergency Department Throughput – Admit Decision Time to ED Departure Time for Admitted Patients	Not Prioritized	1	1.2	0.3	0.6	0.3	0.6	0	3	
EH MU Stage 1	Not Applicable	CQM - EH	ED-2 Subset-2	Emergency Department Throughput – Admit Decision Time to ED Departure Time for Admitted Patients	Not Prioritized		0	0	0	0	0	0	0	
EH MU Stage 1	Not Applicable	CQM - EH	ED-2 Subset-3	Emergency Department Throughput – Admit Decision Time to ED Departure Time for Admitted Patients	Not Prioritized		0	0	0	0	0	0	0	
EH MU Stage 1	Not Applicable	CQM - EH	Stroke-2	Ischemic Stroke – Discharge on Antithrombotics	Not Prioritized	1	1.2	0.3	0.6	0.3	0.3	0	2.7	
EH MU Stage 1	Not Applicable	CQM - EH	Stroke-3	Ischemic stroke – Anticoagulation for A-fib/flutter	Not Prioritized	1	1.2	0.6	0	0.3	0.3	0.9	3.3	
EH MU Stage 1	Not Applicable	CQM - EH	Stroke-4	Ischemic stroke – Thrombolytic therapy for patients arriving within 2 hours of symptom onset	Not Prioritized	1	1.2	0.3	1.2	0	0.3	0.9	3.9	
EH MU Stage 1	Not Applicable	CQM - EH	Stroke-5	Ischemic Stroke – Antithrombotic Therapy by End of Hospital Day 2	Not Prioritized	1	1.2	0.6	1.2	0.6	0.3	0.9	4.8	
EH MU Stage 1	Not Applicable	CQM - EH	Stroke-6	Ischemic stroke – Discharge on statins	Outstanding	1	1.2	0	1.2	0.3	0.3	0.9	3.9	
EH MU Stage 1	Not Applicable	CQM - EH	Stroke-8	Ischemic or hemorrhagic stroke – Stroke education	Not Prioritized	1	1.2	0.3	1.2	0.6	0.3	0.9	4.5	
EH MU Stage 1	Not Applicable	CQM - EH	Stroke-10	Ischemic or hemorrhagic stroke – Rehabilitation assessment	Not Prioritized	1	1.2	0.6	0.6	0.6	0.3	0.9	4.2	

Functionality/Certification

Content

Workflow

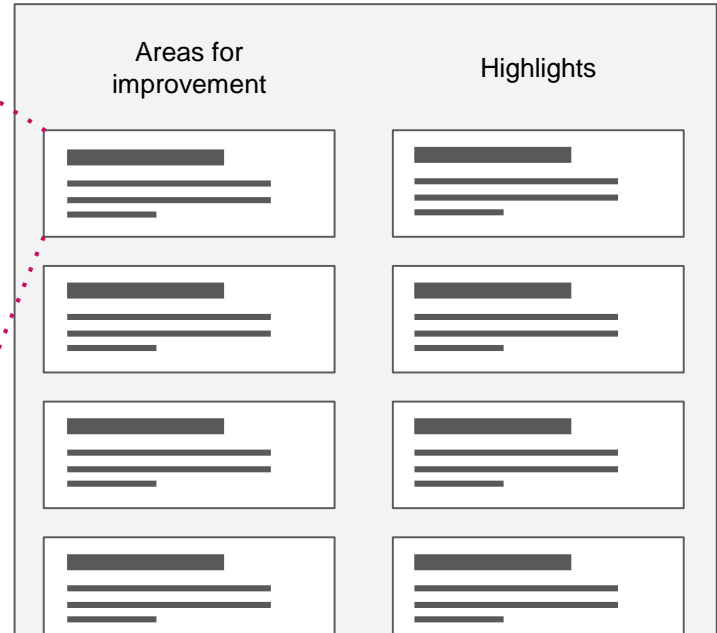
Data

Adoption

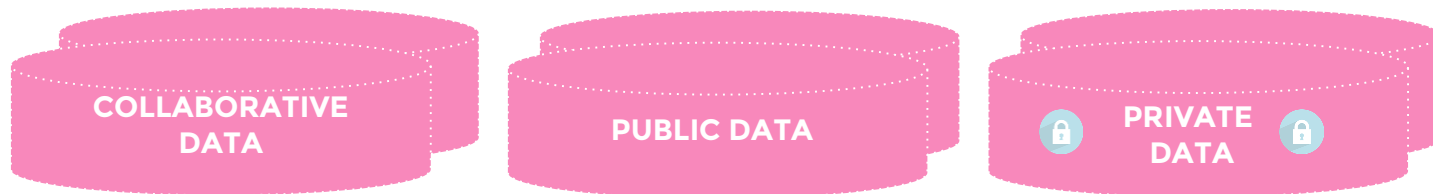
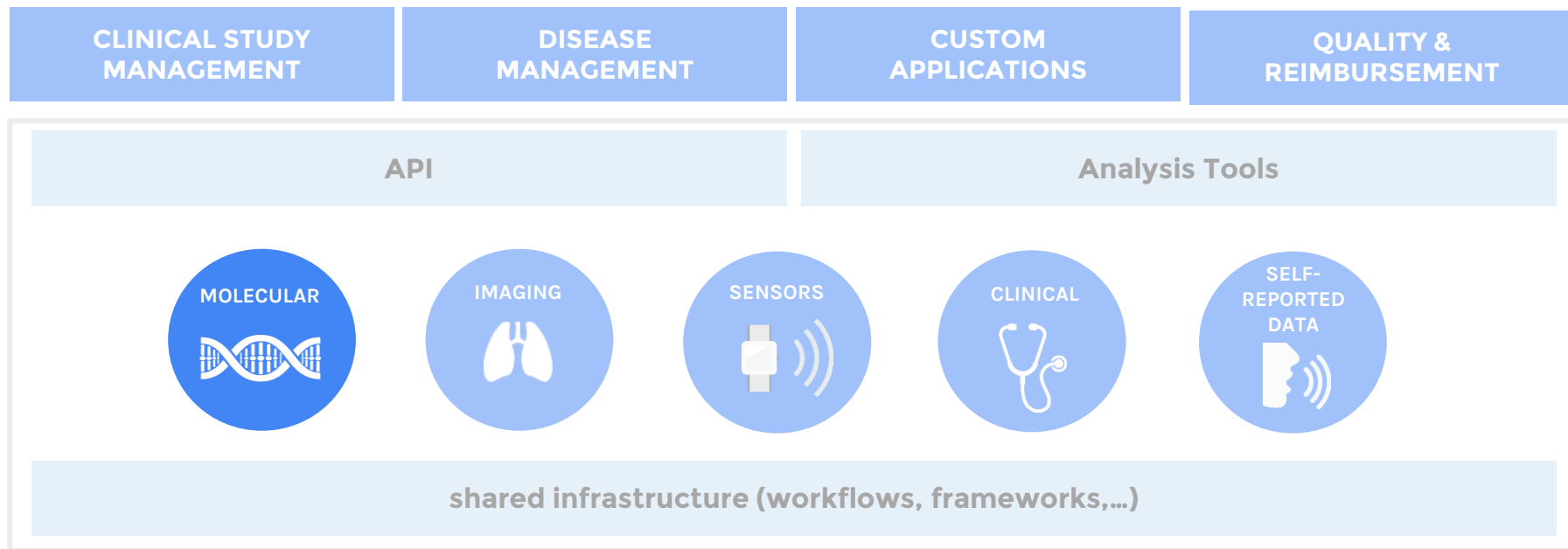
Reporting

Provider analytics

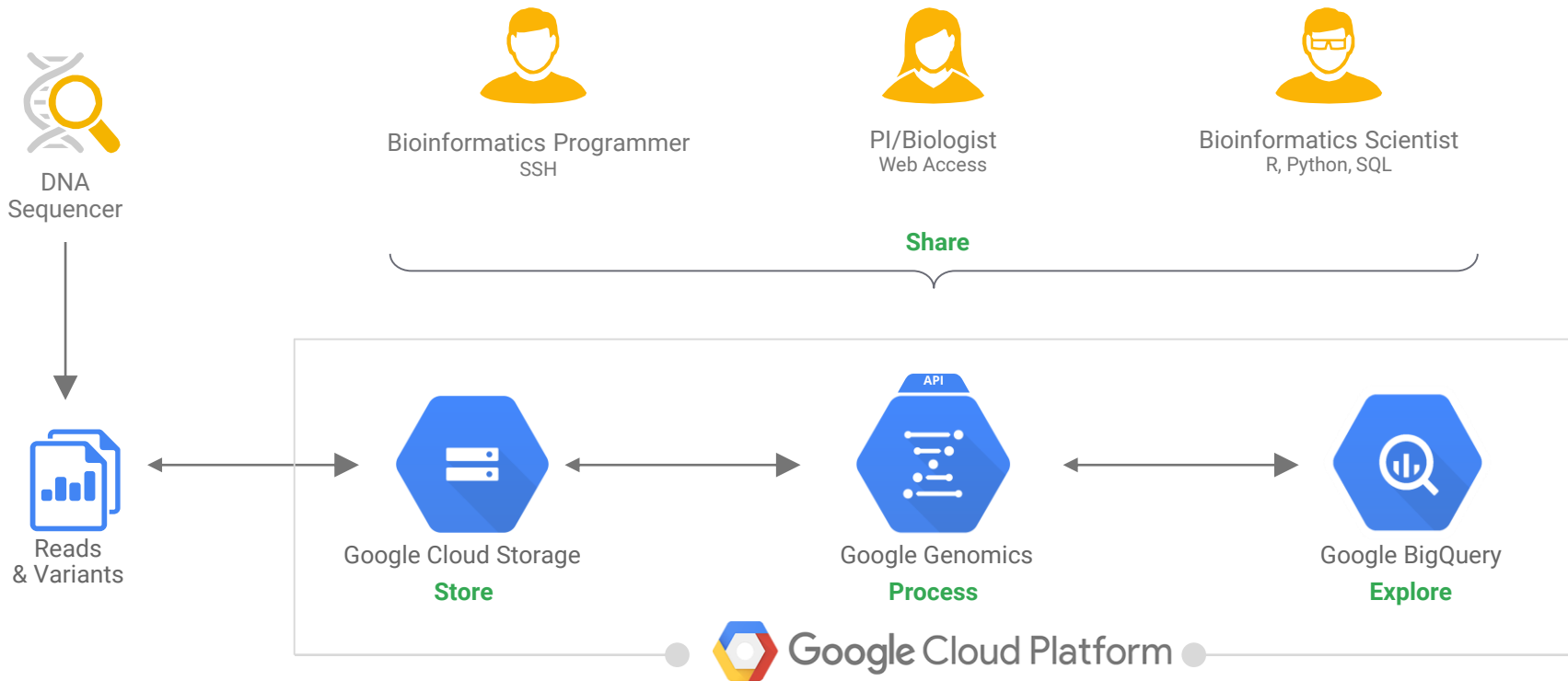
Your hospital had a 10.1% longer length-of-stay for Knee Joint Replacement (127 bed-days which costs \$549,004.20). This change may be driven by severity 2 cases, which are higher by 10.3%. The longer stays in severity 2 could account for 49.5% (63 bed-days) of the total increase.



Genomics Capabilities



Genomics workflow



PrecisionFDA Truth Challenge



President Obama's Precision Medicine Initiative envisions a day when an individual's medical care will be tailored in part based on their unique characteristics and genetic make-up.



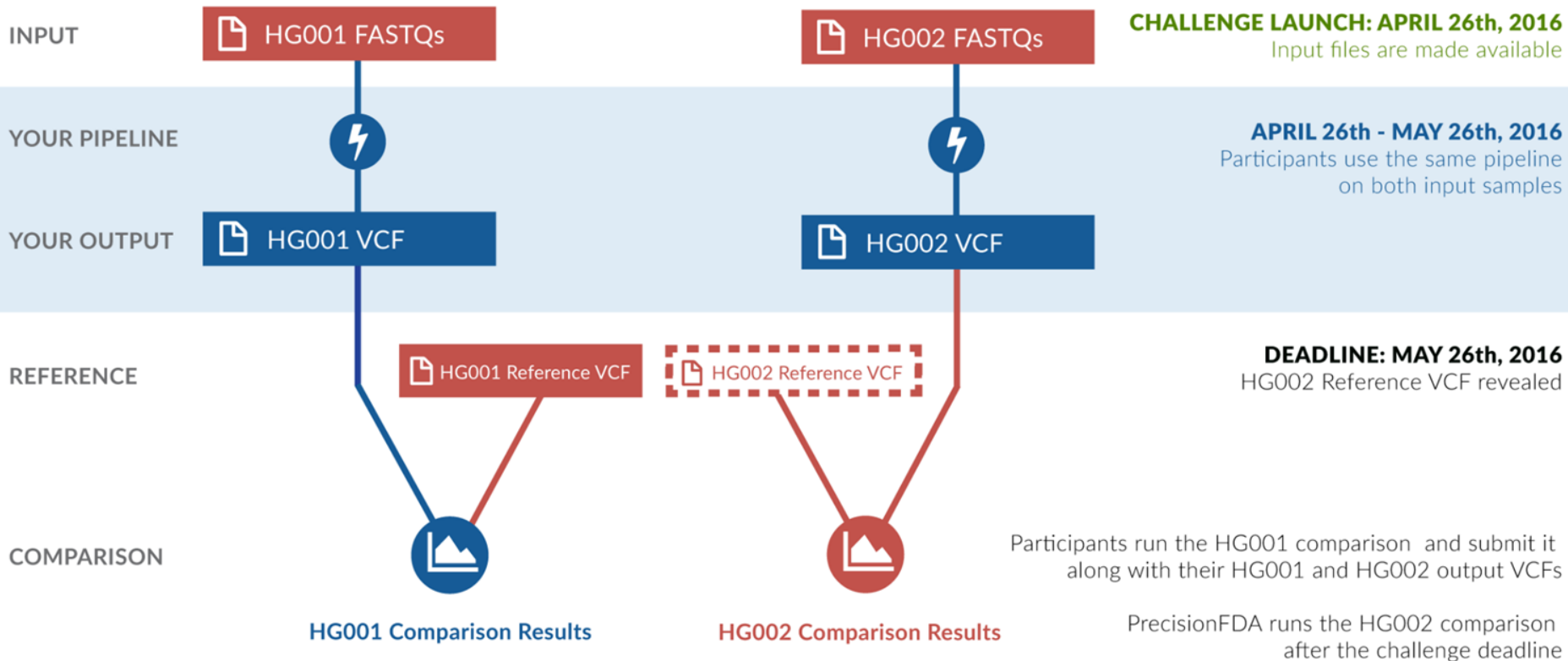
The goal of the FDA's second precisionFDA challenge, similarly to the first challenge, is to continue engaging the genomics community in advancing the quality standards in order to achieve more accurate and consistent results in the context of genetic tests (related to whole human genome sequencing), advancing the goal of better personalized care.



PrecisionFDA invites all innovators to take the challenge and assess their (or their favorite!) software on the supplied human datasets. Participation is voluntary, but instrumental in helping the community prepare for the coming genomic data revolution.

PrecisionFDA Truth Challenge

April 26, 2016 through May 26, 2016



PrecisionFDA Truth Challenge

HIGHEST
SNP Performance



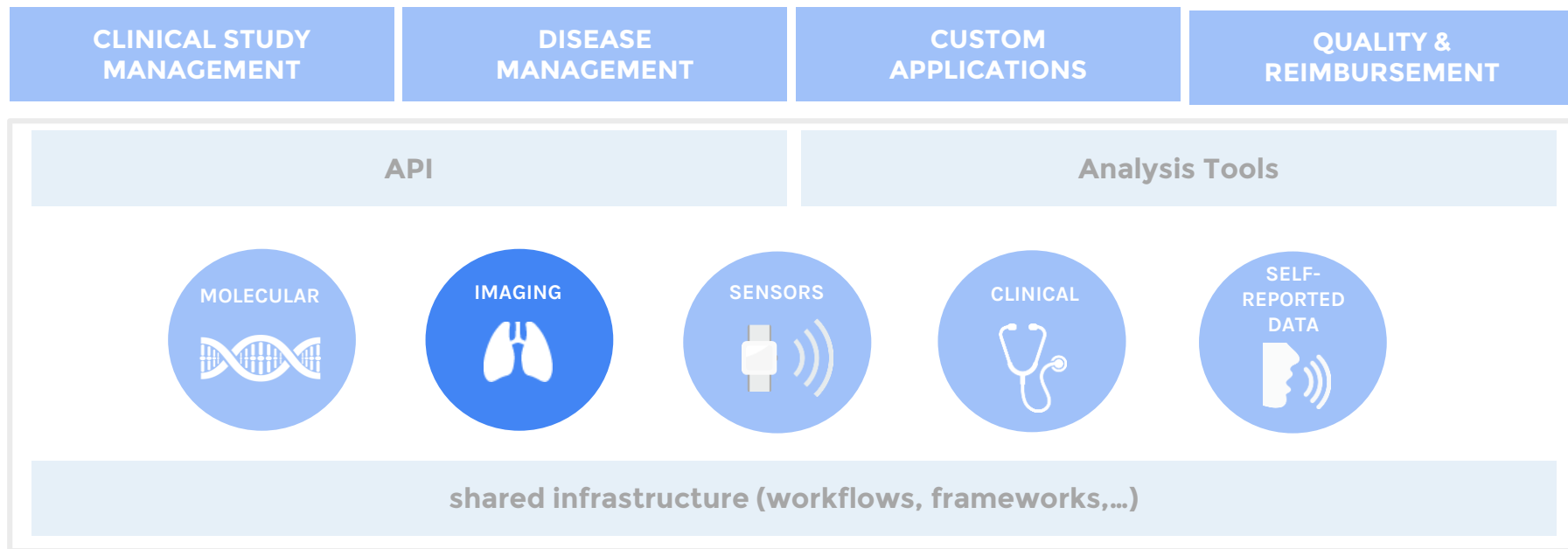
AWARDED TO

Verily Life Sciences

Ryan Poplin Mark DePristo
Verily Life Sciences Team

ENTRY	TYPE	SUBTYPE	SUBSET	GENOTYPE	F-SCORE	RECALL	PRECISION	FRAC_NA	TRUTH TP	TRUTH FN	QUERY TP	QUERY FP	FP GT	% FP MA
--	SNP	*	*	*										
rpoplin-dv42	SNP	*	*	*	99.9587 %	99.9447 %	99.9728 %	19.0681 %	3052930	1689	3052766	832	433	52.0433 %

Imaging Capabilities



Diabetic Retinopathy



Other research possibilities ...

RETINA



EYE DISEASES

Glaucoma
Age-related macular degeneration

SYSTEMIC DISEASES

Stroke & heart attack risk
Diabetic nephropathy, neuropathy
Vascular dementia, Alzheimer's
Mortality? Hospitalizations?

OTHER IMAGING



SKIN CONDITIONS

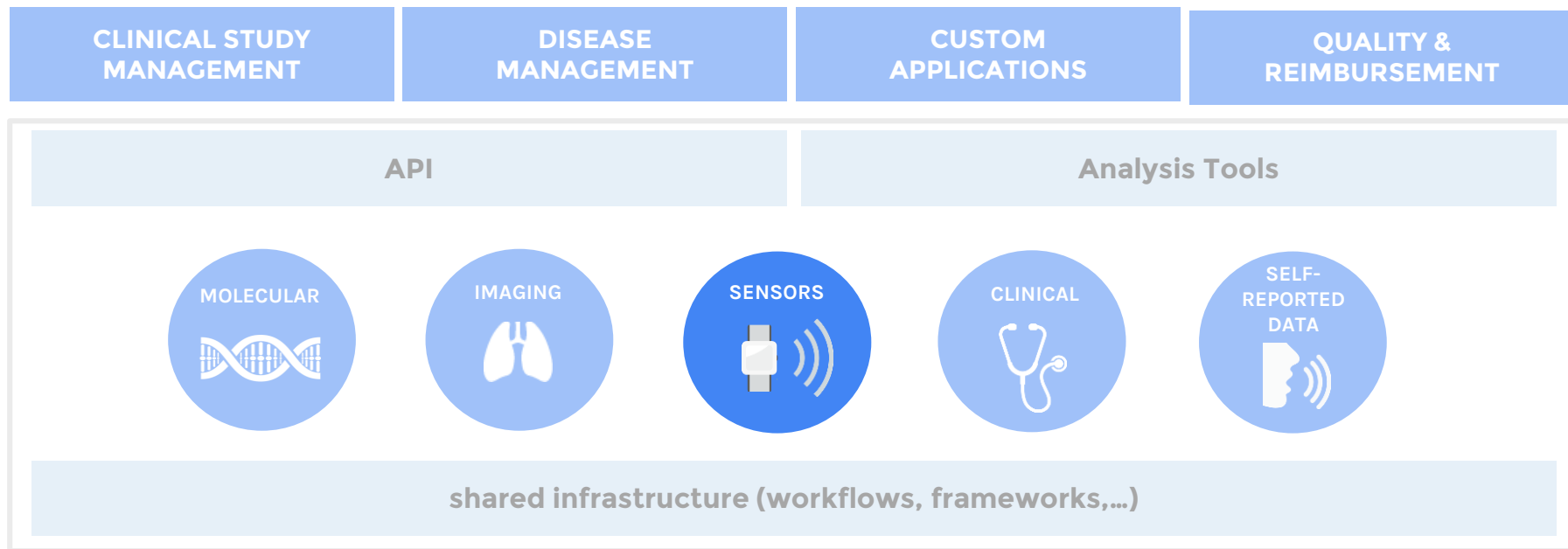
Moles
Skin cancer
Infections
Acne/rosacea
Dermatitis
Hair/nail



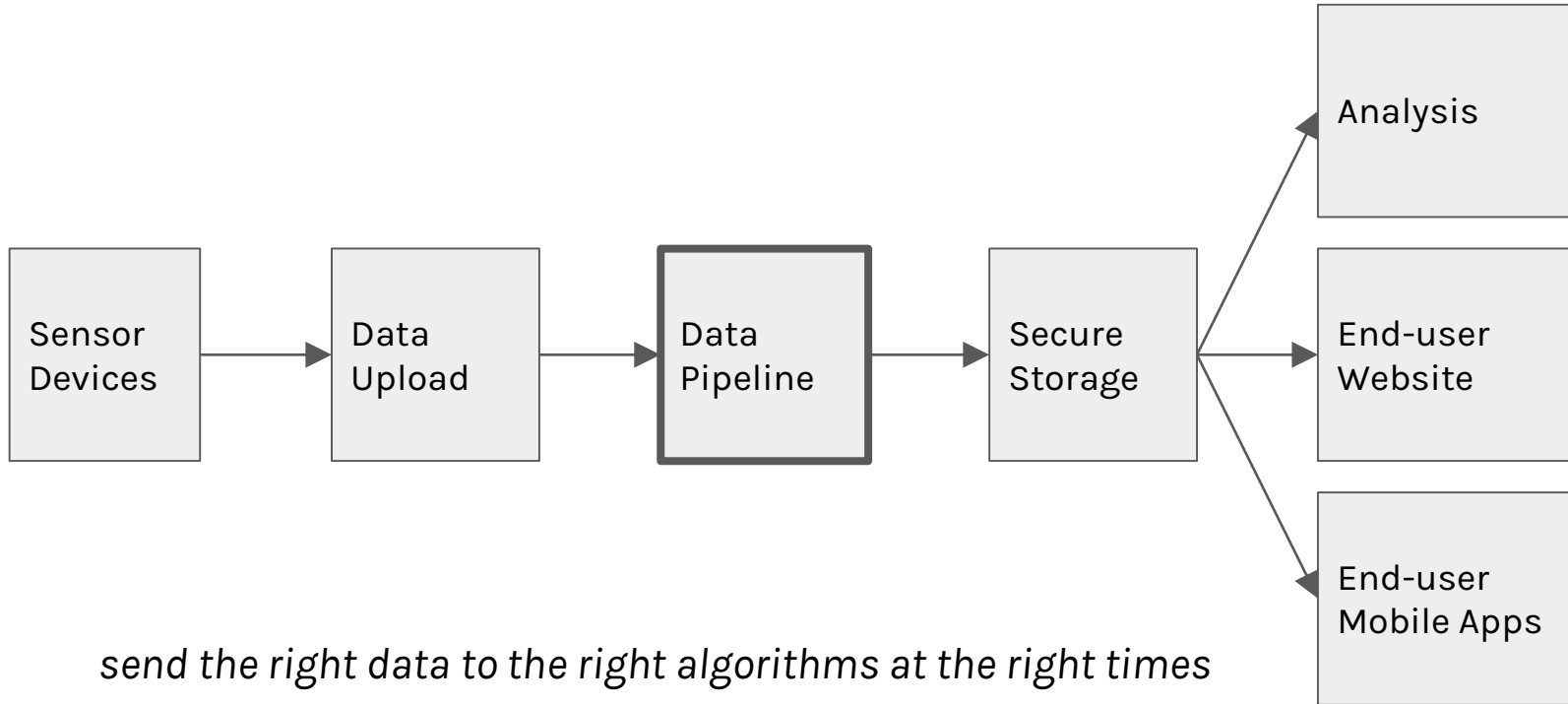
EAR, NOSE, THROAT

Ear infections
Sore throat

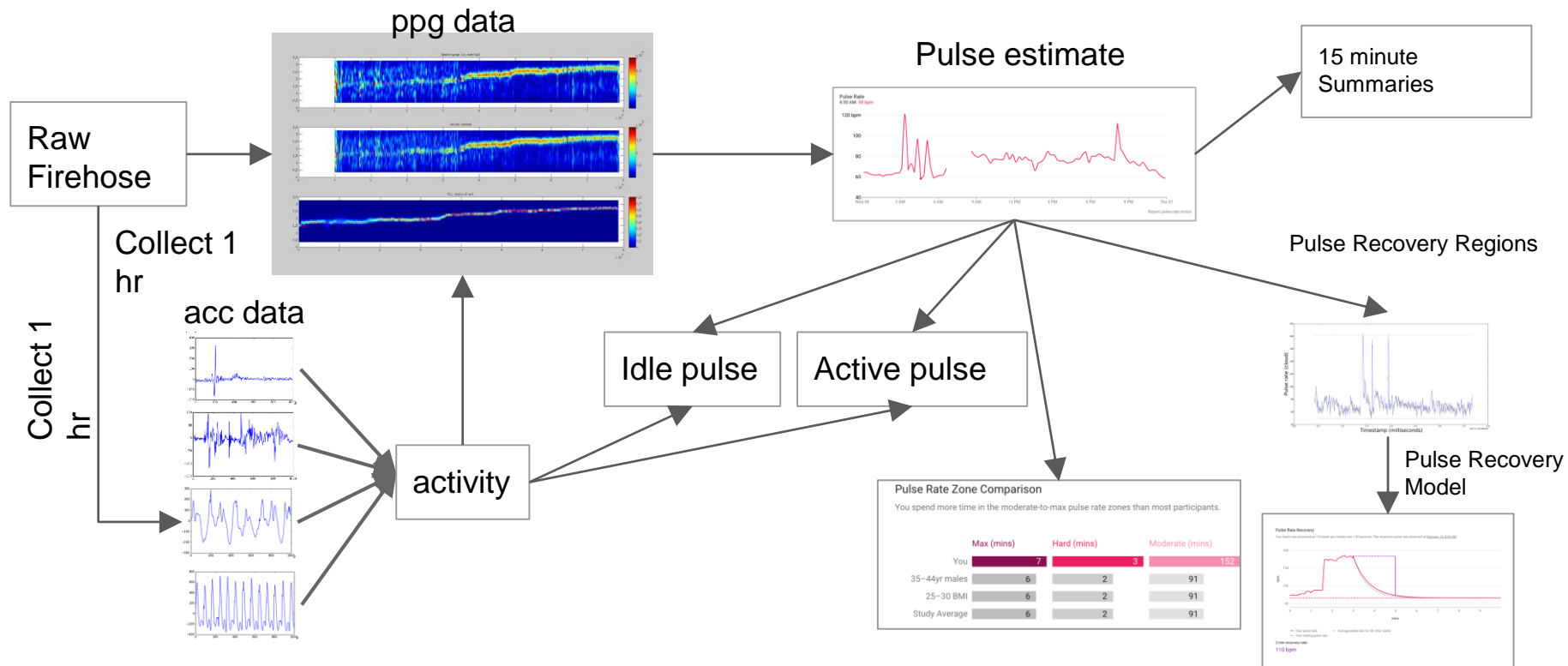
Sensor Data Capabilities



Architecture Overview



Pipeline Example: pulse data computation



Pipeline Example: sleep quantity and quality

Activity Classification
(~18 hrs)

Sleep Onset/Offset Detection

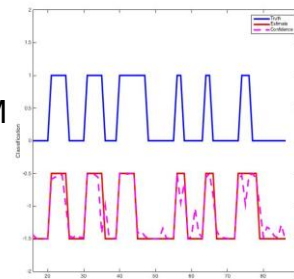
HR Estimation

Raw Firehose
(~18 hours)

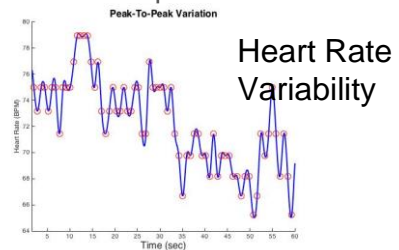


REM
NREM
Model
(Red)

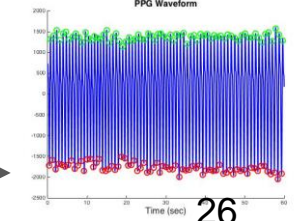
Truth
(Blue)
Conf
(Dash)



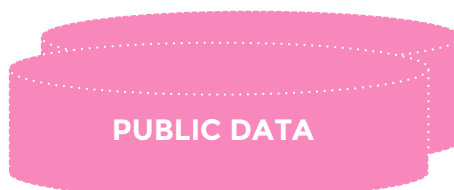
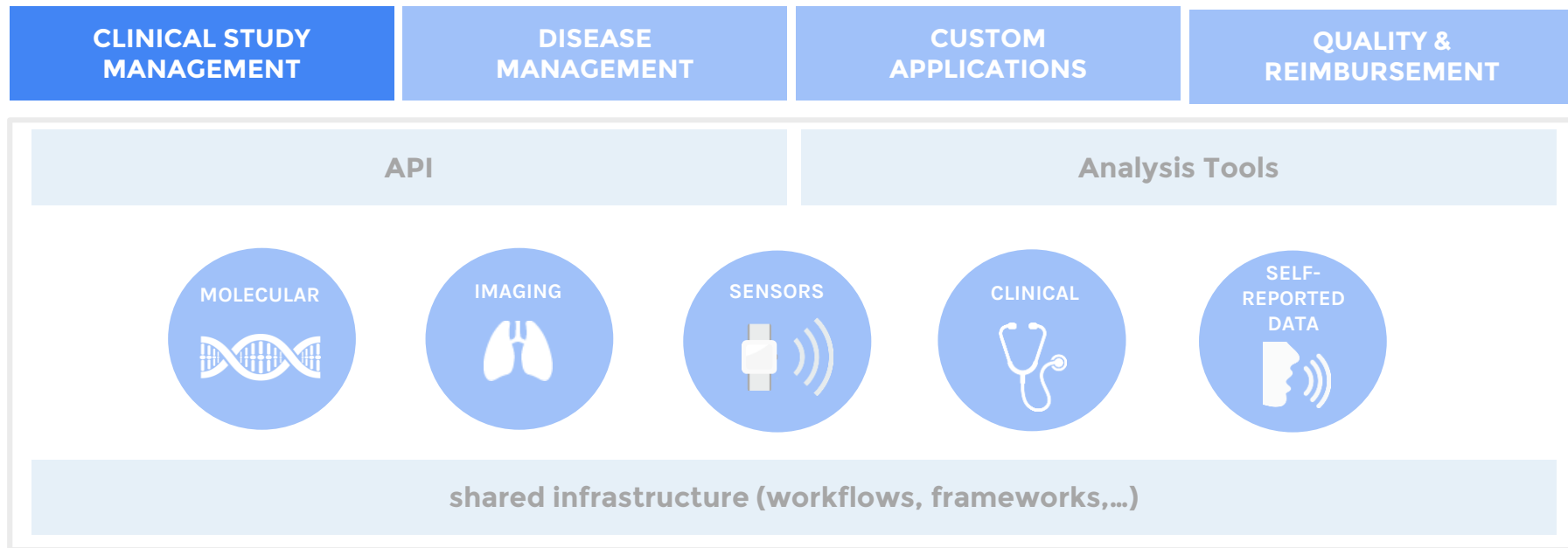
Sleep Stager



PPG Waveform



Solutions: Baseline Study

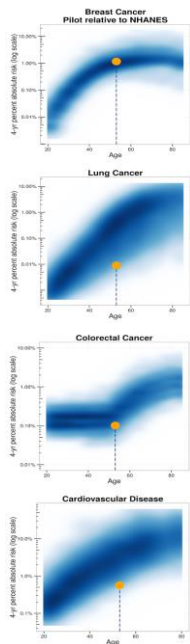


“Google has embarked on what may be its most ambitious and difficult science project ever: a quest inside the human body.”

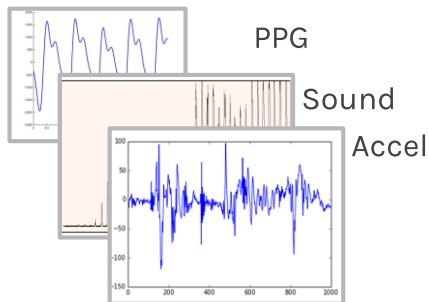
Wall Street Journal | July 2014

Broad and Deep Molecular, Device, and Clinical Phenotyping Data for Each Participant

Clinical Data



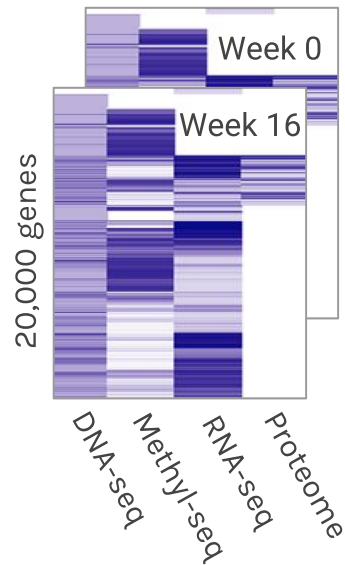
Device Data



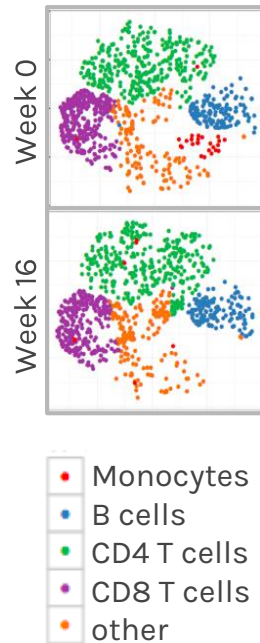
Imaging Data



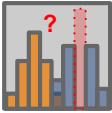
-Omics Data



Immunoprofiling Data



Example: Supported Verily Analyses



Ingestion, preprocessing, QC: Import data at LIMS-level. Automatically survey data quality and highlight areas of concern. Determine pre-analytical, analytical, and biological variability.



Clustering: unbiased or hypothesis-weighted clustering of multi-omics data to reveal unique patterns.



Regression: supervised or semi-supervised methods that import known biological information.



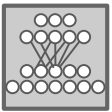
Longitudinal: analysis and sequence prediction in longitudinal data.



eQTL/mQTL: integrative analysis combining multiple genetic data types.

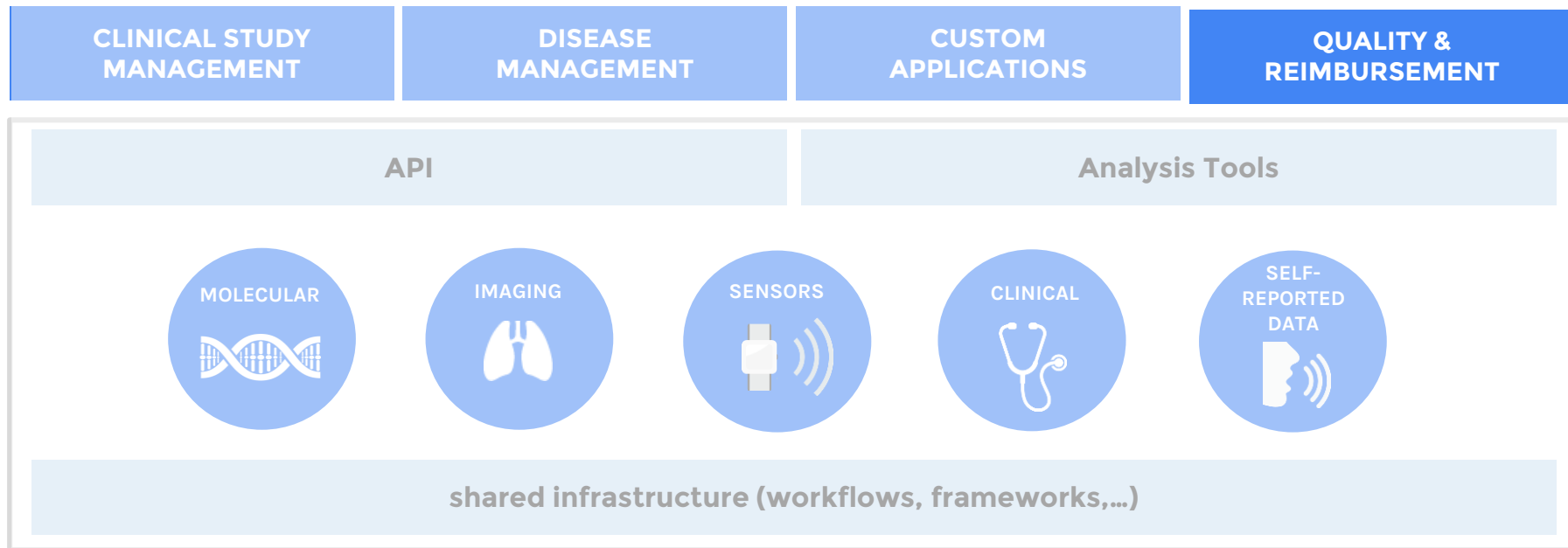


GRS: genomic predisposition; advanced modeling across multiple population data.

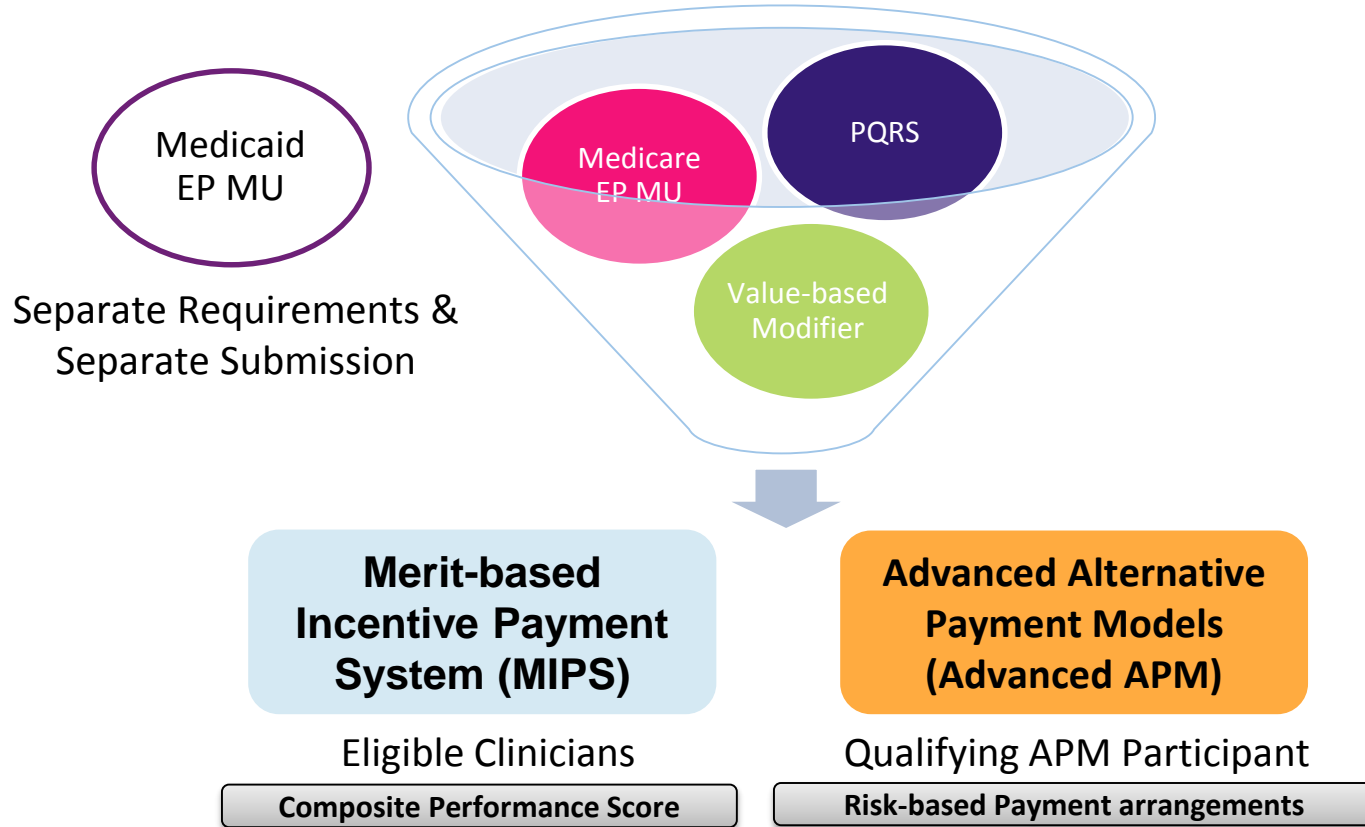


Advanced machine learning: for integrative pathway discovery & analysis, data annotation, quality control, and phenotype-*omics associations.

Solution: Quality Improvement / MACRA



The MACRA Quality Payment Program Consolidates key aspects of three existing physician-based programs



Data Submission Mechanisms for Groups

**Merit-based
Incentive Payment
System (MIPS)**

Quality

- Qualified Clinical Data Registry (QCDR)
- Qualified registry
- EHR
- CMS Web Interface (groups of 25 or more)
- CMS-approved survey vendor for CAHPS for MIPS (must be reported in conjunction with another data submission mechanism)

CPIA

- Attestation
- QCDR
- Qualified registry
- EHR
- CMS Web Interface (groups of 25 or more)
- Administrative claims (if technically feasible, no submission required)

Resource Use

- Administrative claims (no submission required)

Advancing Care Information

- Attestation
- QCDR
- Qualified registry
- EHR
- CMS Web Interface (groups of 25 or more)

Creating the Infrastructure to Support Precision Medicine

Sources

Settings

Data Processing / Google Cloud Based Platform

Solutions & Apps



Epic and Cerner Health Records



Imaging Systems



Lab and Genomic Data



Sensor and PRO data



Community Based Care



Acute Care



Port-Acute Care



Ambulatory Surgery Center



Patients

