UNIVERSITY of WASHINGTON DIGI

PIPELINES, WAREHOUSING, & ANALYTICS

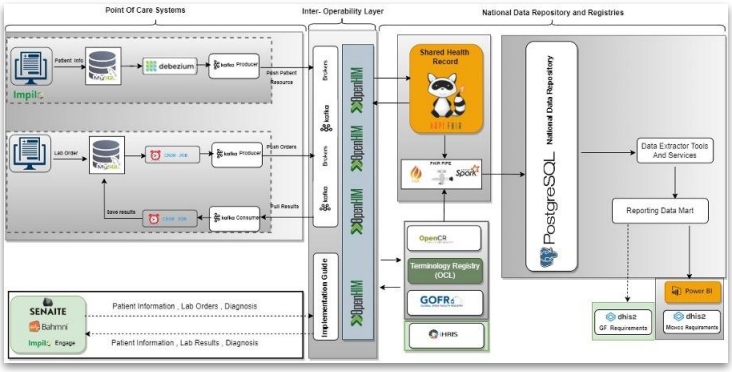
DATA PIPELINES USING FHIR

Some examples of our health information exchanges, FHIR pipeline, and analytics projects

Côte d'Ivoire

I-TECH CIV
Côte d'Ivoire International Training & Education for Health

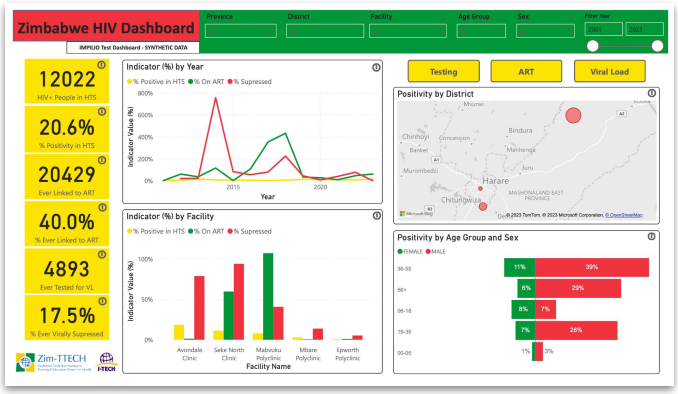
In **Côte d'Ivoire**, DIGI has been a longstanding digital health partner to I-TECH CIV, the Ministry of Health, and the U.S. CDC office under PEPFAR. DIGI is modernizing the national health architecture using OpenMRS v3, OpenHIE with FHIR and OpenHealthStack, and more to **realize a full continuum of care and secondary data use ecosystem**. This includes **real time national patient identification**, **consolidated data warehouse and dashboards**, and more!



Zimbabwe

Zim-TTECH
Zimbabwe Technical Assistance, Training & Education Center for Health

In **Zimbabwe**, DIGI partners with ZimTTECH to provide expert technical assistance and engineering to the Ministry of Health (MoH) to achieve national standards-based health information exchange and data analytics solutions. Using an OpenHIE architecture and OpenHealthStack FHIR Data Pipes, we have **developed a pipeline from the facility-level EMR to a FHIR-first Shared Health Record (SHR), and flattened to an appropriate data warehouse model** with capabilities for generating indicators for reporting to MoH and other funders.



For more information about DIGI guides and country examples for HIEs and Pipelines, visit http://healthinformationexchange.org

DIGI PRINCIPLES

- > Open Source and Global Goods
- > User-Centered Design
- > Standards Based Solutions
- > Upskilling and Local Ownership
- > Flexible and Responsive

DIGI's APPROACH to PIPELINES & ANALYTICS

- > Open Health Stack FHIR Pipes
- > Industry Supported (Google)
- > Broad use among global health partners
- > Optimized for horizontal scalability
- > SQL Support (wider support base for current dimensional modeling techniques)
- > More understandable columnar, flat data structures and meaning

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PIPELINES, WAREHOUSING, & ANALYTICS

Data Analytics

FHIR Pipes

Google supported Open Health Stack (OHS) provides FHIR analytics tools, such as FHIR data pipes (https://github.com/google/fhir-data-pipes) to enable a FHIR data store to be queried for use in analysis and visualization. A sql-on-fhir schema is used to build a columnar data warehouse schema through Apache Parquet files. This technology optimizes for horizontal scalability and distributed storage.

```sql
CREATE OR REPLACE VIEW dim_person AS
SELECT P.id,N.firstname,N.lastname,M.firstname as firstname_maiden, M.lastname as lastname_maiden, P.gender,P.birthDate,I.drivers_license,
       I.ssn, I.mrn, I.passport, I.synthea, Phone.phone_number, Add.city, Add.state, Add.zip
       from patient AS P
LEFT JOIN (
    SELECT id,
    MAX(identifier) FILTER (WHERE system = "urn:oid:2.16.840.1.113883.4.3.25") AS drivers_license,
    MAX(identifier) FILTER (WHERE system = "http://hl7.org/fhir/sid/us-ssn") AS ssn,
    MAX(identifier) FILTER (WHERE system = "http://hospital.smarthealthit.org") AS mrn,
    MAX(identifier) FILTER (WHERE system = "http://standardhealthrecord.org/fhir/StructureDefinition/passportNumber") AS passport,
    MAX(identifier) FILTER (WHERE system = "https://github.com/synthetichealth/synthea") AS synthea
from (
    SELECT P.id, ident.value as identifier, ident.system as system, concat_ws(" ",ident.type.coding.display) as id_type
                  from patient AS P LATERAL VIEW OUTER explode(identifier) as ident
) group by id
) I on P.id = I.id
LEFT JOIN (
    SELECT P.id,names.family as lastname,concat_ws(" ",names.given) as firstname, names.use  from patient AS P
LATERAL VIEW OUTER explode(name) as names
WHERE names.use = "official"
) N on P.id = N.id
LEFT JOIN (
    SELECT P.id,names.family as lastname,concat_ws(" ",names.given) as firstname, names.use  from patient AS P
LATERAL VIEW OUTER explode(name) as names
WHERE names.use = "maiden"
) M on P.id = M.id
LEFT JOIN (
    SELECT P.id,tele.value as phone_number  from patient AS P
LATERAL VIEW OUTER explode(telecom) as tele
       ) Phone on P.id = Phone.id
LEFT JOIN (
    SELECT P.id,add.city as city, add.state as state, add.postalCode as zip  from patient AS P
LATERAL VIEW OUTER explode(address) as add
       ) Add on P.id = Add.id
```

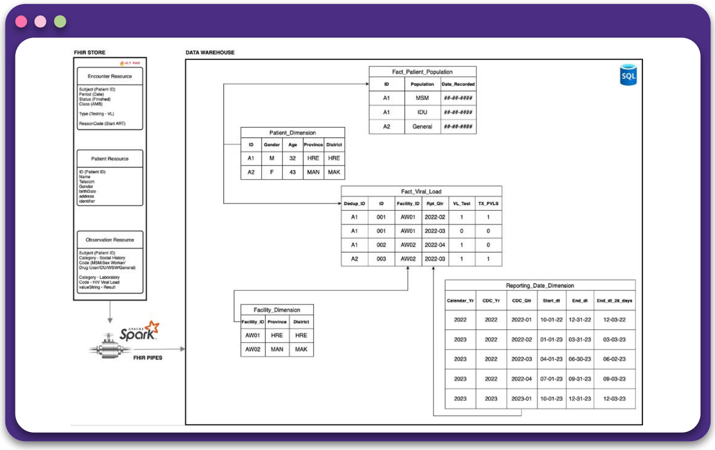
Apache Spark SQL Views

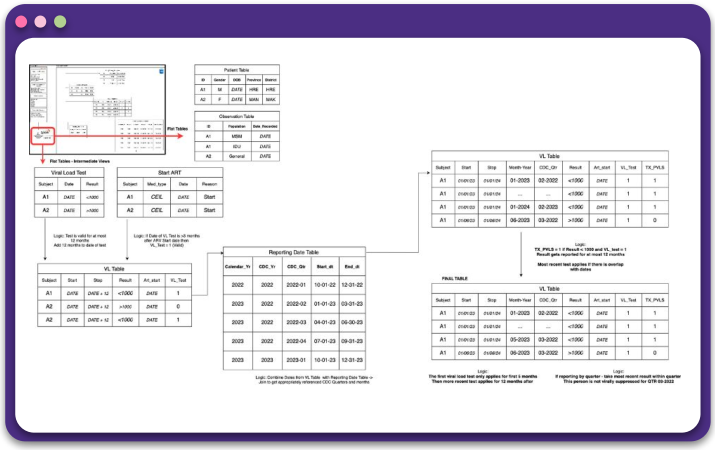
Apache Spark SQL is used to create flattened columnar data views of FHIR data. Nested data within FHIR stores are stored into long tables, organized by patient IDs. These long table views can then be transformed into wide views for further processing into data warehouse schema using dimensional modeling techniques.

	id	firstname	lastname	firstname_maiden	lastname_maiden	gender	birthDate	drivers_license	ssn	mrn
1	105961	Freda902	Bruen238	<null>	<null>	female	1973-04-09	S99980487	999-55-9944	f74dcb3d-03f5-305
2	10830	Gerardo48	Ceja441	<null>	<null>	male	1981-11-25	S99933751	999-40-2702	bf3bcfb3-143f-61c
3	109732	Ollie731	Crooks415	<null>	<null>	male	1970-08-03	S99947058	999-28-5066	b44c3d06-7ace-05b
4	111922	Luis923	Cruz300	<null>	<null>	male	1996-04-27	S99917616	999-24-7537	88cea50e-248d-969
5	112585	Ramona980	Godínez202	Ramona980	Gonzales379	female	1937-04-17	S99946296	999-81-3017	6eb9f136-121e-2f3
6	113208	Neomi684	Hand679	Neomi684	Rath779	female	1940-05-16	S99955948	999-11-3069	ec865d34-e498-5de
7	113945	Monika509	Pollich983	Monika509	Feil794	female	1966-03-08	S99984035	999-50-8221	9d996be3-72e0-763
8	114519	Meredith572	Leffler128	Meredith572	Stiedemann542	female	1973-06-21	S99953575	999-12-5799	4926936e-183c-510
9	115995	Cortez851	Roberts511	<null>	<null>	male	1959-03-17	S99988445	999-79-9808	05e870ed-d6d0-945
10	116904	Bobbye345	Harris789	Bobbye345	Denesik803	female	1988-04-30	S99997680	999-86-8724	52604a6b-c99e-911
11	125242	Frederica279	Olson653	Frederica279	Robel940	female	1966-01-07	S99932159	999-77-8388	2c46dae0-0a31-a67
12	12613	Gregg522	Gutmann970	<null>	<null>	male	1915-04-20	S99960337	999-54-4988	3fb1ad1f-9a1d-055
13	129102	Edgar153	Mohr916	<null>	<null>	male	1966-10-20	S99997633	999-38-1818	f6d6d6e5-6e58-41c
14	137167	Gerardo48	Zulauf375	<null>	<null>	male	1953-03-02	S99938518	999-78-2827	7cf0b556-a4cc-7d4
15	138162	Mose244	Fritsch593	<null>	<null>	male	1984-03-26	S99924602	999-83-4423	ba5b0d1a-c3ad-b98
16	138579	Lanell756	Goodwin327	<null>	<null>	female	1967-05-29	S99916756	999-53-1252	988f3282-6014-aff
17	139285	Meghan514	Halvorson124	Meghan514	Grady603	female	1962-09-24	S99914971	999-25-2282	a10fd43a-9264-8f4
18	143522	Duncan491	McDermott739	<null>	<null>	male	1975-01-04	S99956637	999-83-8085	e83782f9-e104-261
19	144342	Carolyne559	Koelpin146	Carolyne559	Pouros728	female	1955-11-26	S99939624	999-91-2591	0724714f-947b-6ca
20	145888	Byron202	Sauer652	<null>	<null>	male	1969-03-26	S99987327	999-21-9878	dfddba4c-a2c8-08e
21	149751	Wally311	Blanda868	<null>	<null>	male	1999-01-27	S99952544	999-69-2649	879c534d-c512-35c
22	150451	Jonathon205	Effertz744	<null>	<null>	male	1955-07-26	S99949126	999-92-4040	18683b9b-db3e-987
23	152108	Levi940	Gusikowski974	<null>	<null>	male	1992-11-15	S99912330	999-24-2888	b71e39bd-d33f-0b5
24	154241	Kanisha187	Welch179	<null>	<null>	female	1966-10-14	S99987543	999-40-2146	b50ae490-7fbf-d2e
25	154563	Lawerence6	Baumbach677	<null>	<null>	male	1941-10-24	S99950677	999-56-7437	ea8d2576-4a23-490
26	156418	Neomi684	Hand679	Neomi684	Rath779	female	1940-05-16	S99955948	999-11-3069	ec865d34-e498-5de
27	16036	Loren192	Witting912	<null>	<null>	male	1965-09-16	S99997141	999-78-8627	cc4e734c-272f-170

Dimensional Modeling

From flattened table views, fact and dimension tables can be built. Longitudinal records of indicators can be recorded and mapped onto time periods of interest (months, quarters, years). This enables drilling down of indicators through different time periods as well as filtering and slicing data by demographics of interest. These tables can be built from FHIR-based shared health records and associated registries (patient, facilities, etc.). They will also be easily integrated into dashboards such as Apache Superset and Microsoft PowerBI for data visualization and dashboarding.





LET'S COLLABORATE!

To learn more about DIGI, please email us at **digit@uw.edu** or visit **uwdigi.org** and **healthinformationexchange.org**