

**EFFICIENCY
FOR
ACCESS**



UK

ENGINEERS

WITHOUT BORDERS

Appliance Affordability



Funded by:



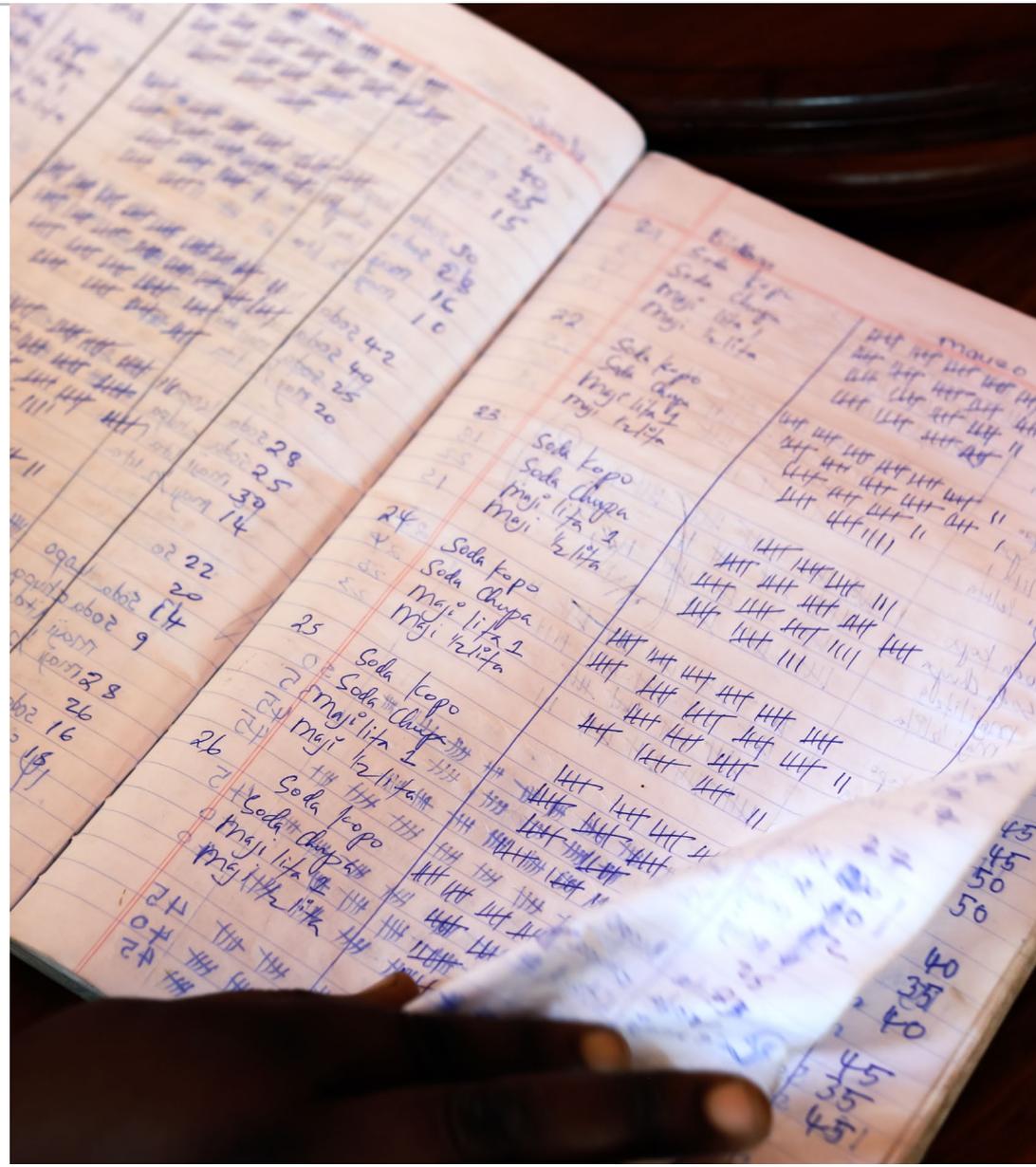
IKEA Foundation



**energy
saving
trust**

Agenda

- ▶ Guest Speakers
 - Matt Carr
 - Alex Clayton
 - Joshua Milburn
 - Ilana Cohen
- ▶ Q&A
- ▶ Webinar feedback survey



Our guest speakers



▶ **Matt Carr – Agsol**



▶ **Alex Clayton – M-KOPA**



▶ **Joshua Milburn – Angaza**



▶ **Ilana Cohen - GSMA**



A G S O L

Solar Powered Agro-Processing Machines

Matt Carr
matt@agsol.com



Nearly 1 billion people have no access to electricity

Most are smallholder farmers and depend on agriculture for their livelihood

THE GOLDEN TRIANGLE OF PRODUCTIVE TECHNOLOGIES FOR AGRICULTURE



MILLING STAPLE FOODS CREATES HARDSHIP FOR OFF-GRID FARMERS



Manual processing: <200W
Laborious, inefficient, a few kg/hr

TECHNOLOGY
& MARKET
GAP



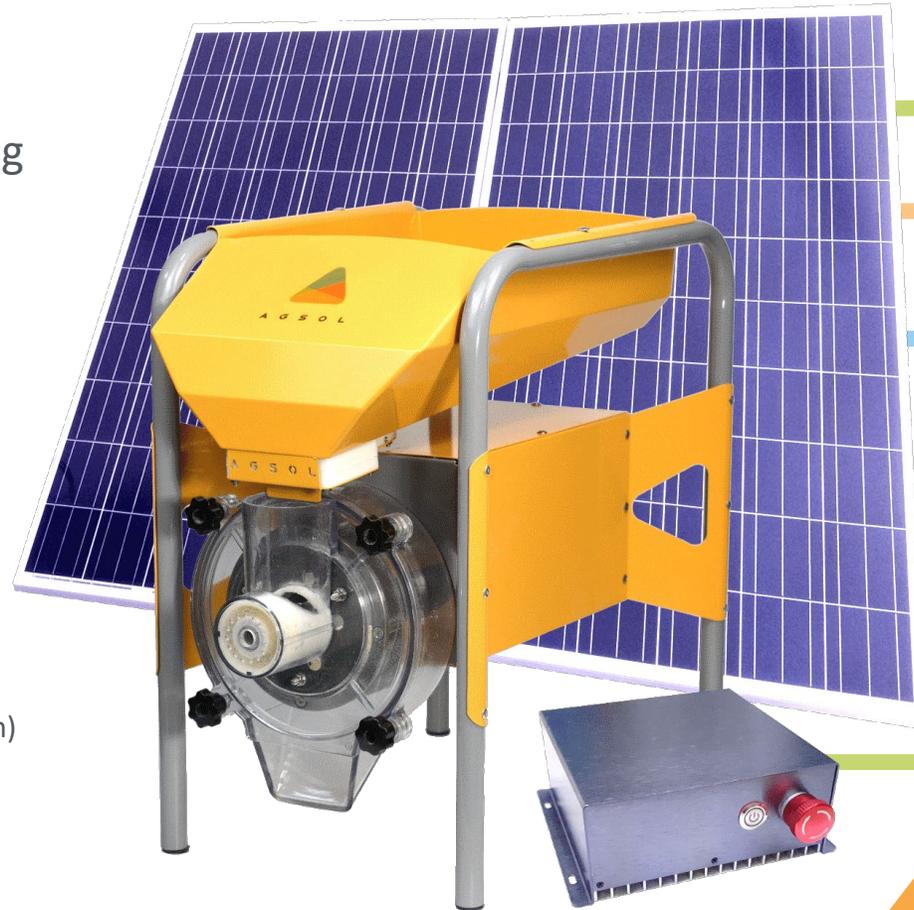
Diesel mills: >7,500W
Costly, larger towns only, >150 kg/hr

Women farmers in Africa spend about 40 billion hours annually processing foods

In East Africa, more than 1 billion USD is spent annually processing maize at diesel mills

STANDALONE SOLAR SOLUTION – MICROMILL

- ✓ Multi-grain processing
- ✓ Direct drive BLDC
- ✓ LFP Battery
- ✓ Smart
- ✓ Interoperable
- ✓ IoT & paygo (coming soon)



Consumer appliances

Education

Lighting

Comm's & technology

Health

...and much more

MICROMILL UNIT ECONOMICS – ASSUMED PRE-FIELD TRIAL

Mill production, power consumption, income

30	kg/h production rate
4	h/day daily use
120	kg/day flour (2kg/hh)
\$0.05	\$/kg milling charge
\$6	\$/day gross income

Customer business case highlights

\$ 1500	Mill purchase price (MSRP)
\$300	Down payment (20%)
\$50	Monthly payback (24 month financing)
\$1.65	Daily payback
\$ 100	\$/month customer net profit during financing
\$ 150	\$/month customer net profit after financing

THE REALITY HAS BEEN DIFFERENT – TO BE DISCUSSED

Efficiency for Access Design Challenge

Alex Clayton



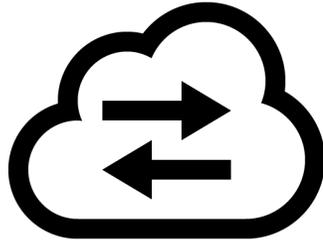


Components of PAYG Model



Product

Design or source a quality product that people need, value and will use every day



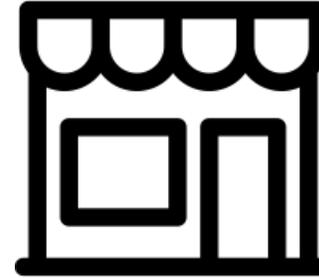
Connectivity

Develop a way to speak with your devices to manage credits and performance



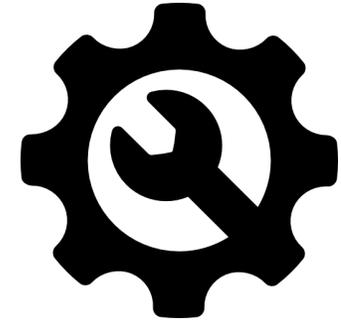
Payments

Process payments and manage sophisticated loans for a distributed customer base



Sales

Develop or partner with a salesforce to reach your target customers



Servicing

Manage product and payment issues to keep customers satisfied and paying

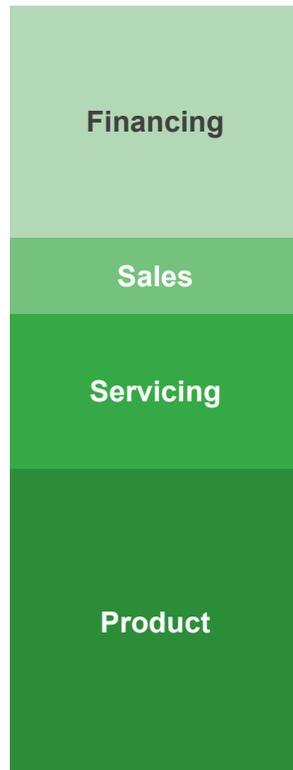
The complex nature of PAYG means that products need to be designed with the complete value chain in mind



Unit Economics

PAYG devices need to be affordable for the target customer every day but it is not just about product cost

PAYG Cost Drivers (Illustrative)



- PAYG is a complex and expensive business model. That complexity must be ‘priced in’ from the beginning, even if it is an estimate. Underestimating will cost you more than the customer in the long term
- Customer research should consider the total price to the customer, not just the product cost. ‘Willingness to pay’ research is very difficult, but always worthwhile.
- Features and technologies need to be weighed up against their cost – if they are too expensive, the product will not have a market. Well-executed, simple solutions can be extremely effective!
- Customers need to wake up every day and choose to pay you. Make sure the product offers reliable value and quality for its entire lifecycle.



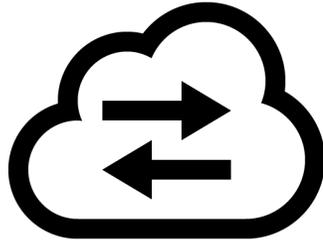
Building PAYG into your Product

Things to consider when designing a PAYG-first product:



Product

- Customer segment
- Existing demand?
- Suitability for PAYG?
- Affordability
- Open or closed system?
- Productive vs. home-use?
- End-of-life (E-Waste)



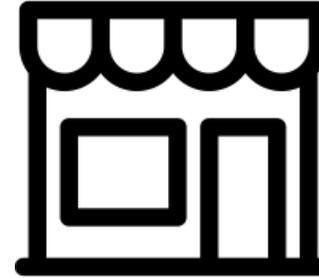
Connectivity

- Method/technology (2G/4G/SMS/NFC)
- Quantity and quality of data collected
- Frequency of data transfer
- Level of diagnostics or remote triage



Payments

- Payments technology in market
- Loan structure and intelligence
- Frequency of payments
- Static vs dynamic pricing
- Financing mechanism



Sales

- In-house vs. partnered?
- Mobile stock, or shop-based?
- Size of warehouse and retail outlets?
- Suitability for rugged environment?
- Security and stock management



Servicing

- Number of accessories and breakable parts
- Remote diagnostics
- Size and nature of field support
- Size and nature of call centre support



Device Interoperability: Nexus Channel (Core)

Efficiency for Access Design
Challenge Affordability of
Appliances Webinar | March 2021

Today: (Mostly) Standalone PAYG Devices

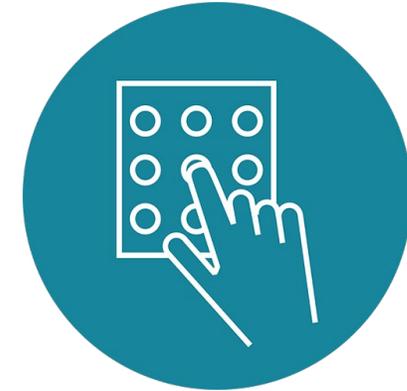
- Home lighting, handheld lamps
- Household energy use (TV, phone charging)
- **Often independent devices, no 'single point of control'**



Photo credit: BioLite

Some Challenges

- “Independent” PAYG control systems
 - “Buy 20W PAYG SHS, then buy separate 20W PAYG TV”
 - User enters separate tokens into each device to ‘top them up?’
- No energy prioritization / load management
 - User has a TV and a fridge powered from same SHS
 - Can the fridge be configured to ‘reserve’ enough battery to last through the night?
- Devices from Manufacturer X can’t communicate with manufacturer Ys
 - Differing connectors, voltages, communication protocols, interfaces



Future: Larger, Interconnected Systems

Expect more:

- Refrigeration, fans
- Solar Water Pumps
- Computers, smartphones
- PULSE (“Productive Use Leveraging Solar Energy”) Products



SoXin QM-850



Agsol
Solar-Powered
Hammer Mill



Steca PF 166-H

Appliance image credits: [Lighting Global](#)

How can devices from different manufacturers communicate in a shared language, i.e. be interoperable?*

- *assuming they can communicate at all

More generally...

- How can these devices communicate with each other in a secure way?
- How can devices from different manufacturers communicate in a shared language, i.e. be interoperable?*
 - *assuming they can communicate at all



Do we want to reinvent the wheel?
Is this applicable only to PAYG situations?

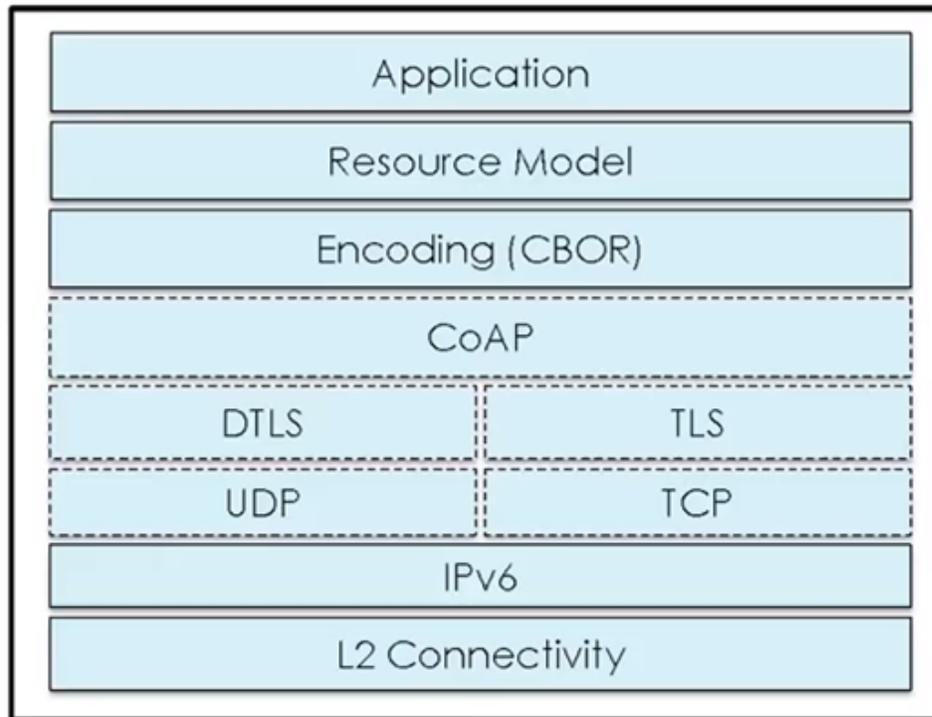
Let's use existing open standards

ISO/IEC 30118-1:2018

Open Connectivity Foundation (OCF) Specification

(available at no cost on the [OCF website!](#))

Let's use existing open standards



OCF Stack

Constrained device classes



- RFC 7228

Name	Data size (e.g., RAM)	Code size (e.g., Flash)
Class 0, C0	<< 10 KiB	<< 100 KiB
Class 1, C1	~ 10 KiB	~ 100 KiB
Class 2, C2	~ 50 KiB	~ 250 KiB

Must accommodate (at a minimum) OS + Network stack + drivers +
IoTivity-Constrained application

What is Nexus Channel Core?

- An application layer for device \leftrightarrow device communication on constrained hardware:
 - ... facilitating interoperability between devices/appliances produced by different manufacturers
 - ... agnostic to underlying link/transport layer
 - ... with optional application layer security (“Full” Nexus Channel) which can be controlled by external platforms
 - ... which is critical for PAYG applications, among others

Why do we need an application layer standard?

- Provide a common abstraction that works with multiple link layers
 - Ex: OpenPAYGO Link, Bluetooth, other low power local networks
- Provide security that may not be present at transport layer, consistently
- Leverage existing work and facilitate interoperability
 - Ex: Many resource models we need already exist, and Angaza is standardizing models specific to Nexus Channel security and PAYG applications

Applications

- Communicating PAYG state securely, i.e. enabled or disabled
- Collecting telemetry data from appliances
- Load balancing (sharing limited battery resources)
- ... anything a device manufacturer wants!



What's Next?

1

- ⓘ **Resource Model: Local Energy Price** resource model wanted
 #6 opened on Sep 30, 2020 by jjmilburn
- ⓘ **Resource Model: Inductive Stovetop** resource model wanted
 #5 opened on Sep 30, 2020 by jjmilburn
- ⓘ **Resource Model: Fan** resource model wanted
 #4 opened on Sep 30, 2020 by jjmilburn
- ⓘ **Resource Model: Well and/or pump** resource model wanted
 #3 opened on Sep 30, 2020 by jjmilburn
- ⓘ **Resource Model: TV** resource model wanted
 #2 opened on Sep 30, 2020 by jjmilburn

We can continue to own and manage this with input from the industry

OR

We can work to have this overall process managed by another entity

2

Resource Type Registry (rtr) value	Resource Type (rt)	Specification
101	angaza.com.nexus.core.battery	battery.oas.yaml
102	angaza.com.nexus.core.energy.generation	energygeneration.oas.yaml
103	angaza.com.nexus.core.energy.consumption	energyconsumption.oas.yaml
201	angaza.com.nexus.core.drlc	drlc.oas.yaml
202	angaza.com.nexus.core.operatingmode	operatingmode.oas.yaml
301	angaza.com.nexus.core.samplelog	samplelog.oas.yaml
65000+	development	reserved for development/testing

<https://github.com/angaza/nexus-channel-models>

“Battery” Resource

Retrieve current battery status

This Resource describes the attributes associated with a battery, and allows authorized devices (authorized via a separate system, e.g. full Nexus Channel security) to update the battery 'low state of charge' threshold, if available.

The minimum set of properties to implement are `cp` and `mv`.

Example `GET` response body in CBOR:

```
BF627662192D73626370183262746814626361197D000626473
F5626367F5626C62F5626674F462737304FF
```

Adapted from OCF spec `oic.r.energy.battery`

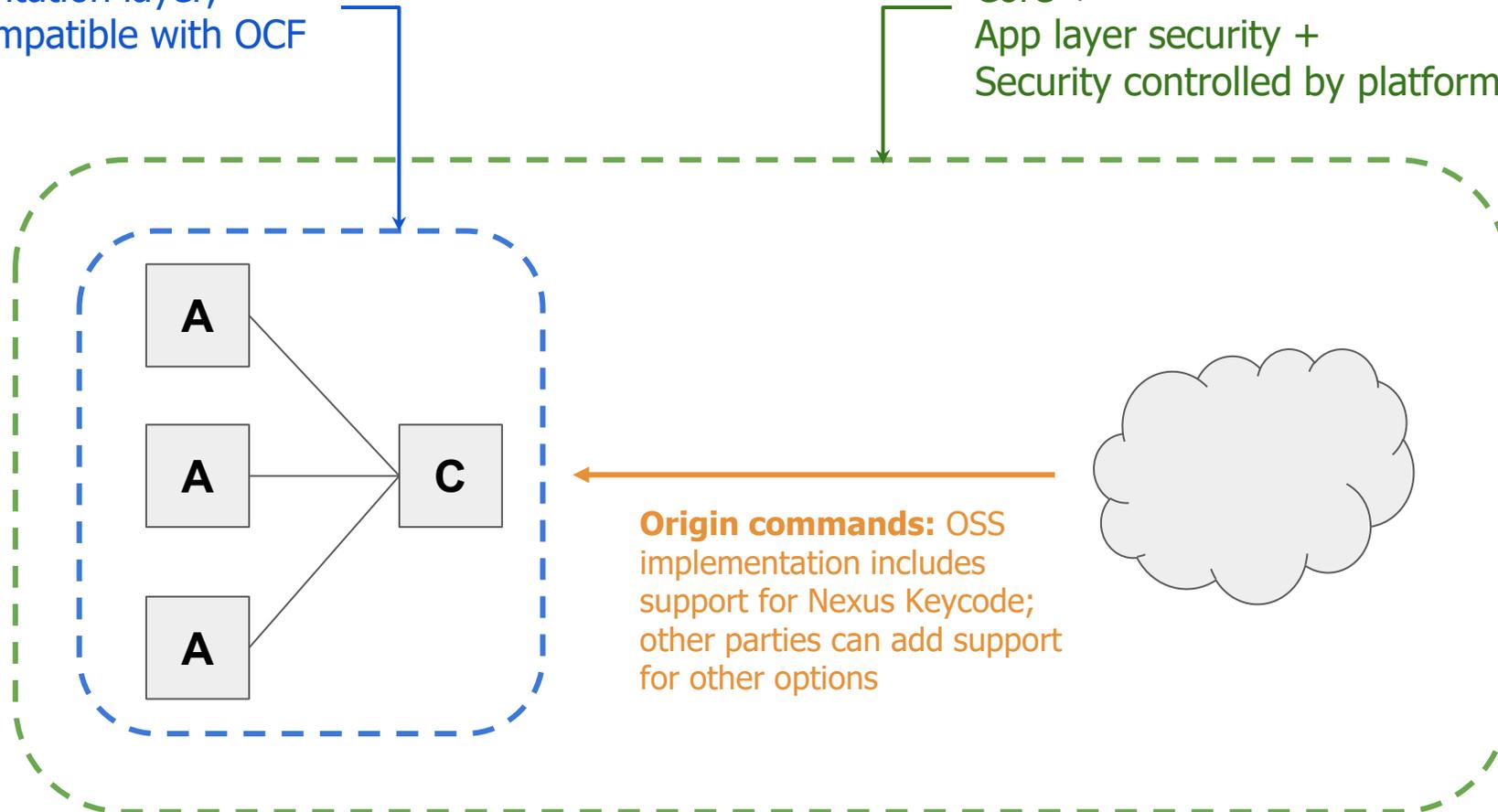
https://angaza.github.io/nexus-channel-models/resource_types/core/101-battery/redoc_wrapper.html

```
GET /batt
Response samples
205
Content type
application/json
Copy Expand all Collapse all
{
  "rt": [ ... ],
  "rtr": 101,
  "if": [ ... ],
  "vb": 11635,
  "cp": 50,
  "th": 20,
  "ca": 32000,
  "ds": true,
  "cg": true,
  "lb": true,
  "ft": false,
  "ss": 4
}
```

Nexus Channel & Nexus Channel Core

NEXUS CHANNEL CORE:
App & presentation layer,
based on/compatible with OCF

NEXUS CHANNEL:
Core +
App layer security +
Security controlled by platform



Current status

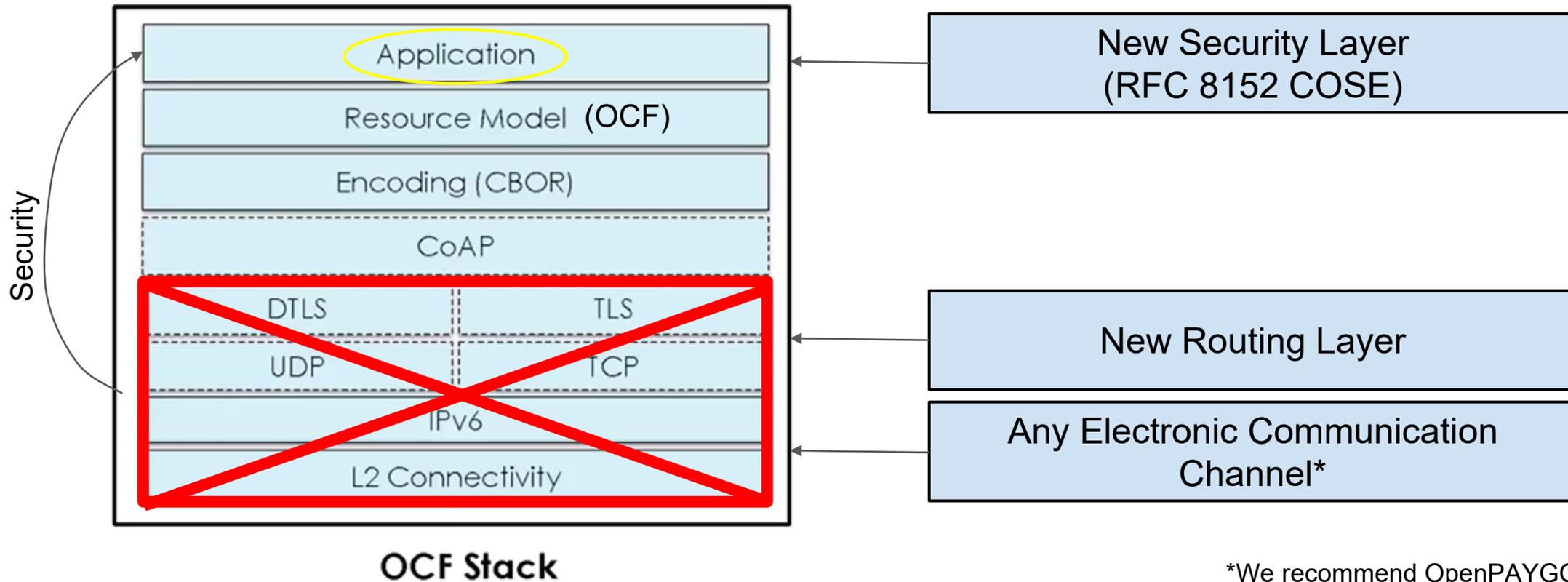
- Release of Nexus Channel Core 1.0 in embedded library available on [GitHub](#)
 - Has a working 'battery' resource example
- We are actively working with Solaris to make OpenPAYGO Link + Nexus Channel (Core) the standard in the PAYG industry
- Angaza has been granted funding from [Efficiency for Access](#) to bring Nexus Channel to market and establish it as an open standard
- **Excited to watch new resource models develop to support new applications beyond "PAYG"**

Figure 17: PULSE Products Are Used in a Wide Range of Applications



(Via [GOGLA](#))

Let's use existing open standards



*We recommend OpenPAYGO Link for wired interoperability.

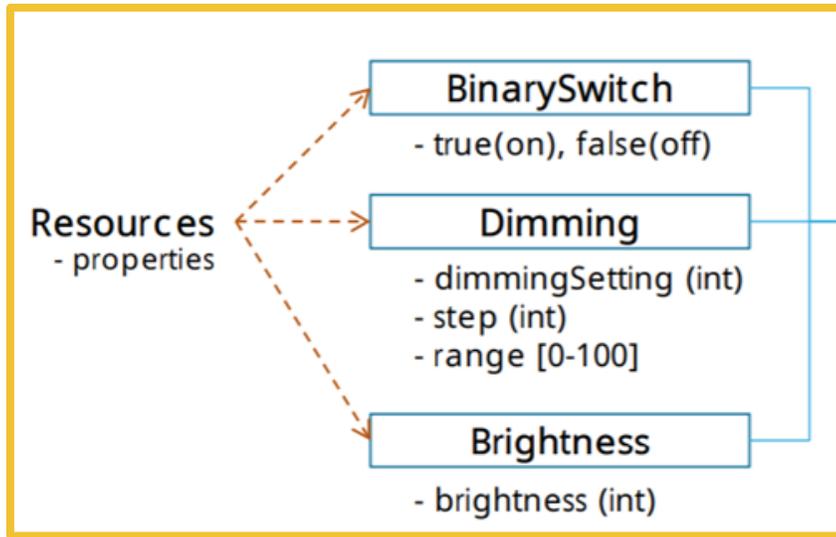
What is Nexus Channel? (more specifically)

- An implementation of a subset of OCF, inspired by IoTivity Lite, targeted to class 0 devices running on lightweight/unsecured transport layers
- An application layer security scheme based on RFC 8152 CBOR Object Signing and Encryption (COSE)
- A system for conveying “origin” commands from an external platform that mediates secured communication between devices
- An open source implementation: Angaza has released a MIT-licensed embedded library
- An open standard: Parties are free to write their own implementations



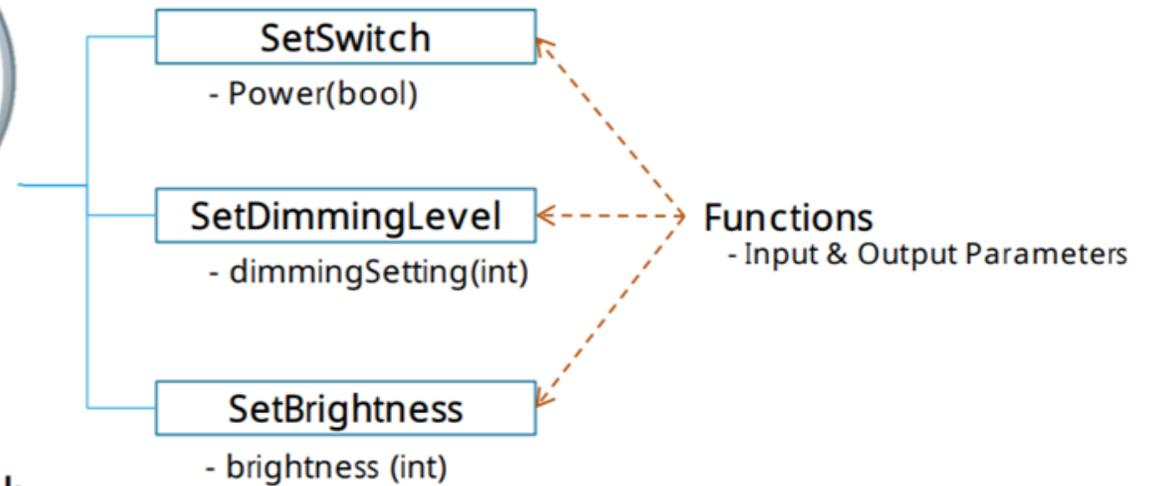
Approaches to definition of various Things

- By defining resources of things and its properties



e.g., Light bulb

- By defining functions/operations of things



- (no Verbs) + Objects
- *Fixed set of verbs (CRUDN) from transport layer will be used
- Resource model in RESTful Architecture (e.g., W3C, CSEP, etc.)

- (Verbs + Objects)
- RPC model



Resources

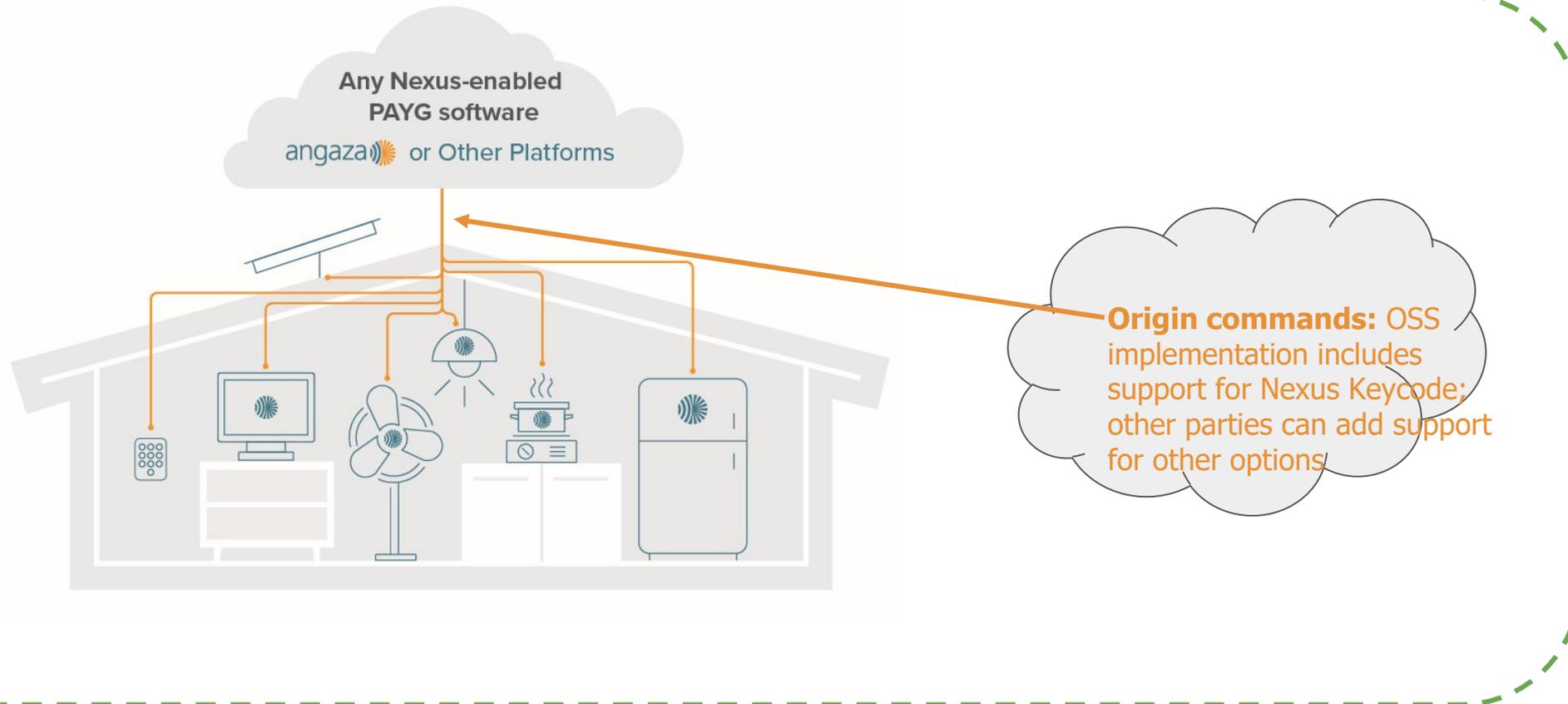
- A device model contains one or more Resources to describe a real world entity
- Each Resource contains Properties that describes an aspect that is exposed through a Resource including meta-information related to that Resource
- Each Resource contains Interface(s) that provides first a view into the Resource and then defines the requests and responses permissible on that view of the Resource

└── RETRIEVE, UPDATE, etc.

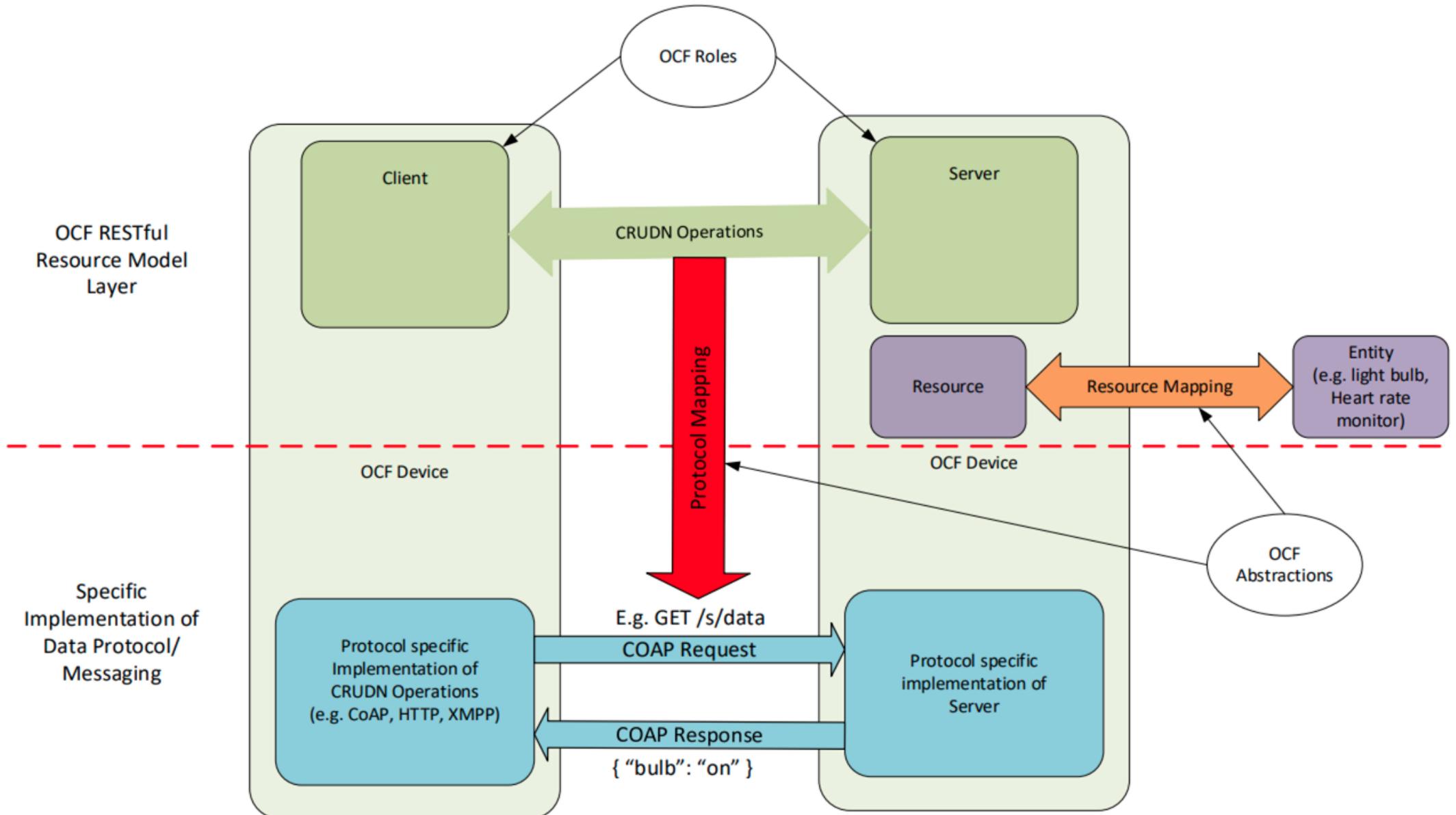
Nexus Channel - One Application Example (PAYG)

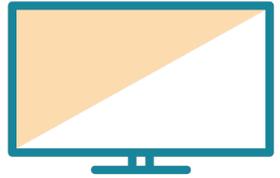
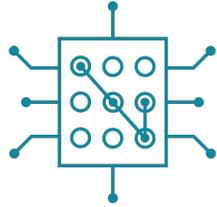
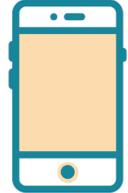
NEXUS CHANNEL:

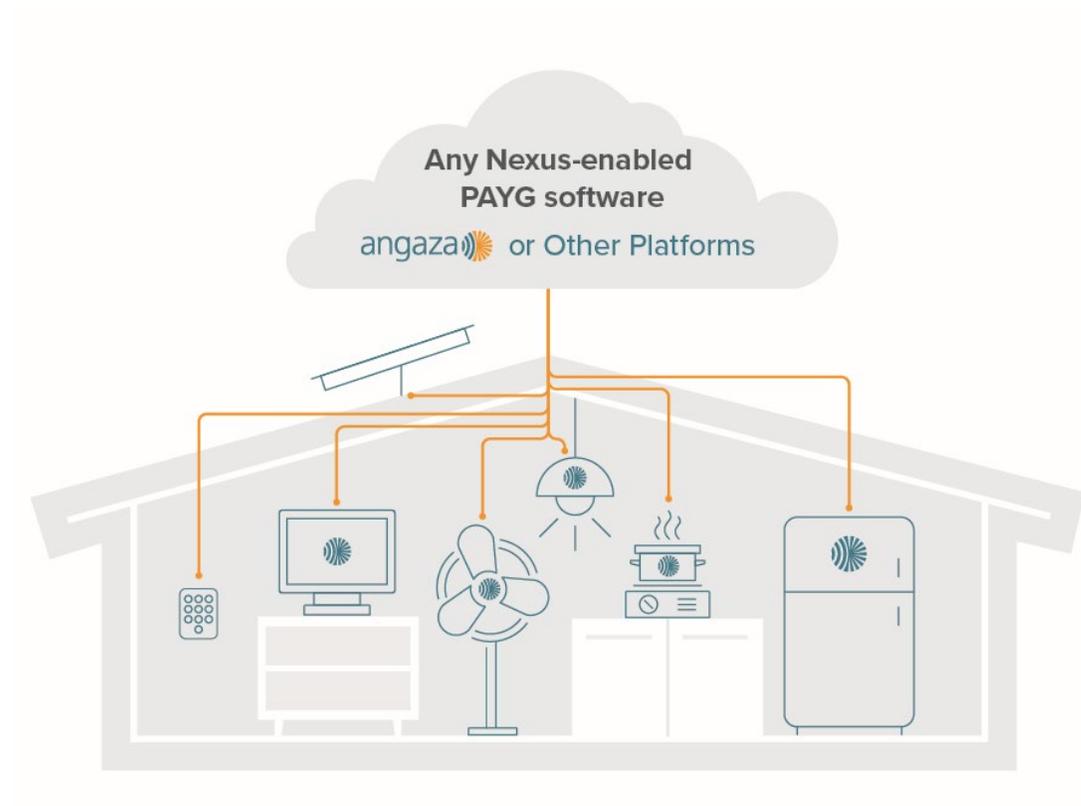
Core +
App layer security +
Security controlled by platform



DEVICE INTEROPERABILITY: NEXUS CHANNEL CORE





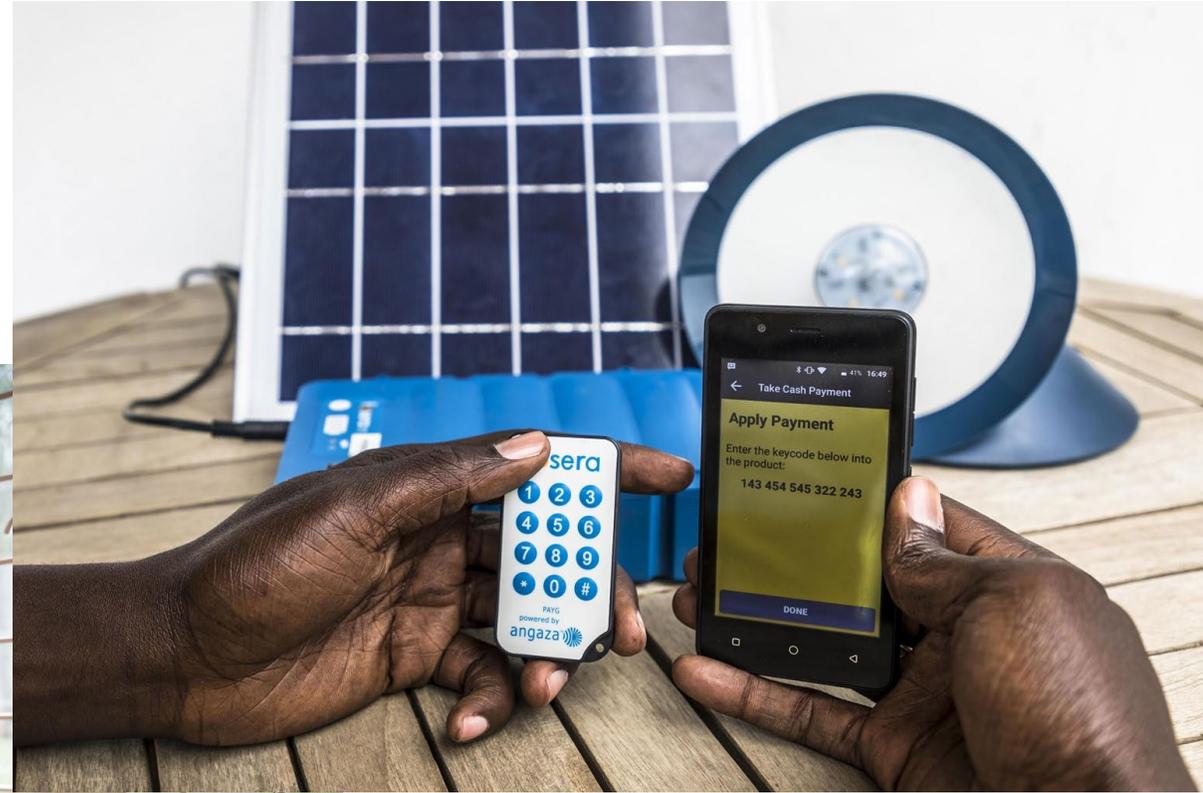


Today: (Mostly) Standalone PAYG Devices

- Home lighting, handheld lamps
- Household energy use (TV, phone charging)
- **Often independent devices, no 'single point of control'**



Photo credit: BioLite



More here:
<https://www.dropbox.com/sh/>

Requirements (from a PAYG perspective)

- PAYG “accessories” can be enabled/disabled according to the state of a PAYG “controller” device (usually an SHS).
- Accessories can be restricted to function only when linked to one specific controller.
- Communication between controllers and accessories is “secure”.
- Messages from the PAYG account platform to controllers can be encoded in existing communication types (namely, keycode/token).



GSMA Mobile for Development Utilities:

Off-Grid Energy Appliances, Mobile Operators and Affordability

Efficiency for Access Design Challenge Webinar 17 March 2021

Ilana Cohen, Acting Head of Programme, Mobile for Development Utilities

17/03/2021

GSMA Mobile for Development Utilities Overview

Who we are

The GSMA represents the interests of mobile operators worldwide.

The GSMA Mobile for Development Foundation drives innovation in digital technology to reduce inequalities in our world.

Programme Mission

Billions of people continue to lack access to utility services such energy, waster, sanitation, waste-management and transport that are essential for life.

Our mission is to enable affordable and reliable access to sustainable utility services for low-income populations, particularly in urban and peri-urban areas, through digital solutions and innovative partnerships.



The GSMA Mobile for Development (M4D) Utilities programme is funded by the UK Foreign, Commonwealth & Development Office (FCDO), and supported by the GSMA and its members.

Key Programme Activities

> RESEARCH AND INSIGHTS

Generate rigorous evidence on innovative solutions to essential service provision by gathering insights from our Innovation Fund grantees, conducting research with partner organisations with deep expertise in utility service provision.

> ACHIEVING IMPACT AT SCALE

enabling access to essential, sustainable, urban utility services for low-income populations through digital solutions and innovative partnerships.



> TECHNICAL ADVICE TO MOBILE OPERATORS, MUNICIPALITIES, AND UTILITY SERVICE PROVIDERS

> DE-RISKING AND CATALYSING INNOVATIVE URBAN UTILITY SERVICES

> PARTNERSHIP FACILITATION AND CONVENING OF KEY ECOSYSTEM STAKEHOLDERS

Synergies Between Off-grid Energy & Mobile Operators

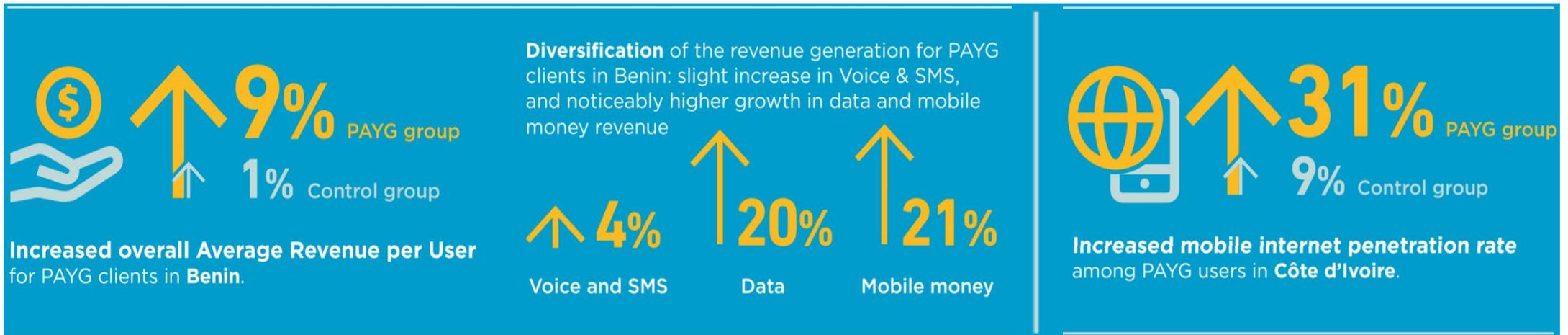
For PAYG solar/appliances:

- Payments
- Remote Monitoring
- Communication with staff/clients
- Big Data Analytics

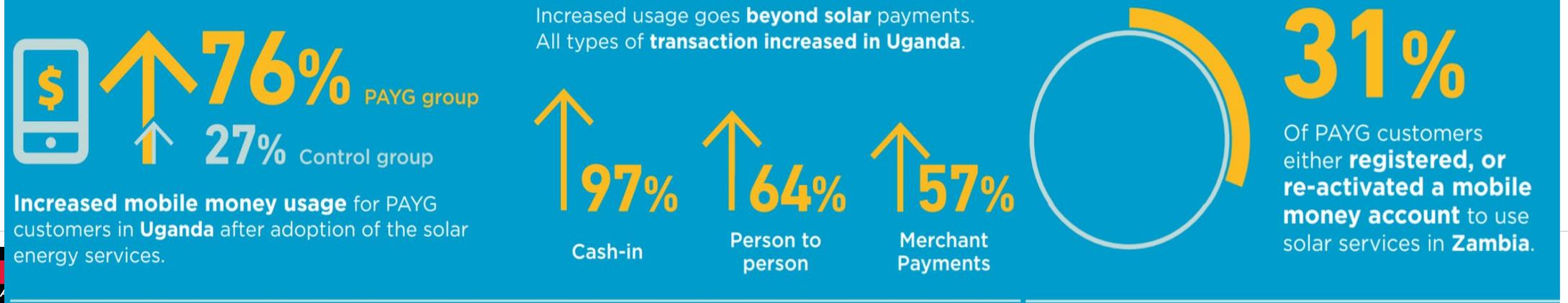


The Value for Mobile Operators

5-country study comparing PAYG and non-PAYG customers' mobile money, mobile services and ARPU



Key Results:



Considering Affordability From the Mobile Angle

- Mobile operator assets may not always reduce the costs of sales and distribution
 - Brand, agent networks, stores
 - See recent [blog](#)
- Mobile money fee structures vary across markets
 - See [Mobile Money Toolkit](#) for Utility Service Providers
- Mobile data costs related to remote monitoring solutions vary
 - Keypad vs GSM, business model vs technical controls
 - Different network technologies, network availability
 - Key design considerations around indicators, frequency and mode of collection
 - See the [IoT development journey](#) for utility enterprises in emerging markets
- The costs of the loan, vs product costs and getting the right product market fit
- The potential role of digital tools in government/donor financing:
 - End-user subsidies (blogs forthcoming); results-based financing

An Evolution of PAYG Solutions Beyond SHS, Energy

- PAYG started with solar home systems, but is being applied to:
 - Solar Irrigation & other agri appliances, Smartphones, Cooking Gas...
 - Water: pre-paid handpumps (rural), household connections (urban), digital kiosks (both)
 - Sanitation: container-based service solutions (not locking tech)

Resources:

- [Intelligent Utilities for All](#)
- [Digital Utility Solutions for the Urban Poor](#)
- [Scaling Digital Solutions in the Water Sector – Lessons from CityTaps and Wonderkid](#)
- [Mobile Money Inclusive Tech Lab](#)
- [GSMA Instant Payment Notification Hub](#) – Transitioned to Beyonic

Thank you

For further information please go to
www.gsma.com/m4dutilities

@GSMAm4d #M4dutilities

icohen@gsma.com

Programme soon to be “Digital Utilities”



This initiative is currently funded by the UK Foreign, Commonwealth & Development Office (FCDO), and supported by the GSMA and its members.



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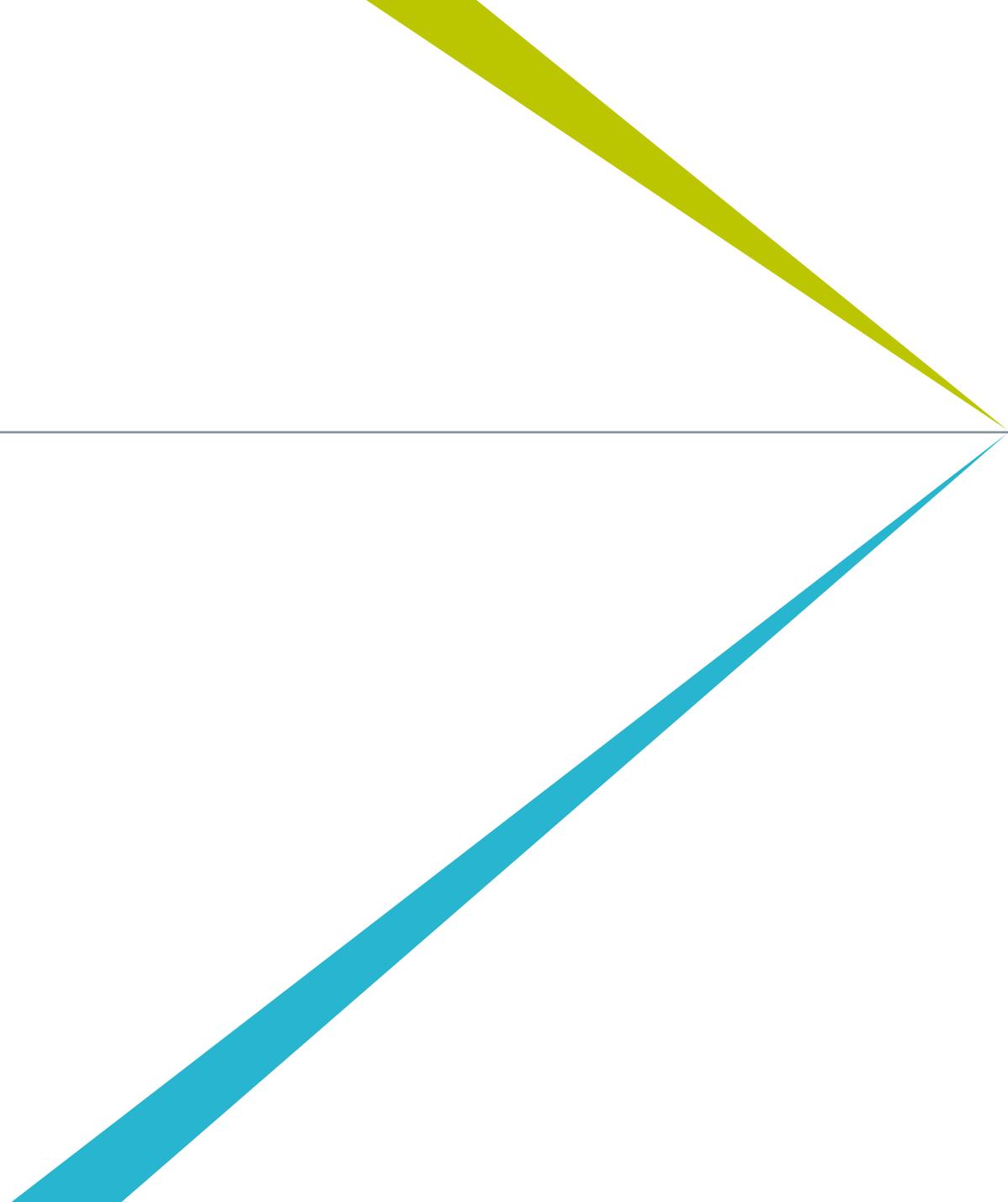
Q&A



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Short feedback survey



[Bit.ly/EforADCFeedbackSurvey](https://bit.ly/EforADCFeedbackSurvey)



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