SECURE HOME GATEWAY PROJECT

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cira

BUILDING A BETTER
ONLINE CANADA

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Today's home network and IoT products and solutions lack secure testing and design. Home network require active monitoring to mitigate the risks of attack.

home network = home and small business network

The home network of the future must be safe, private, secure and most of all easy to use.

The IETF HOMENET WG is making progress at making it easy to use

The Home network must be reachable from the internet seamlessly and securely

IPv6 makes connectivity to the home seamless and visible
We must make it secure

The home network grows to include personal and wearable IoT, inside and outside the home…

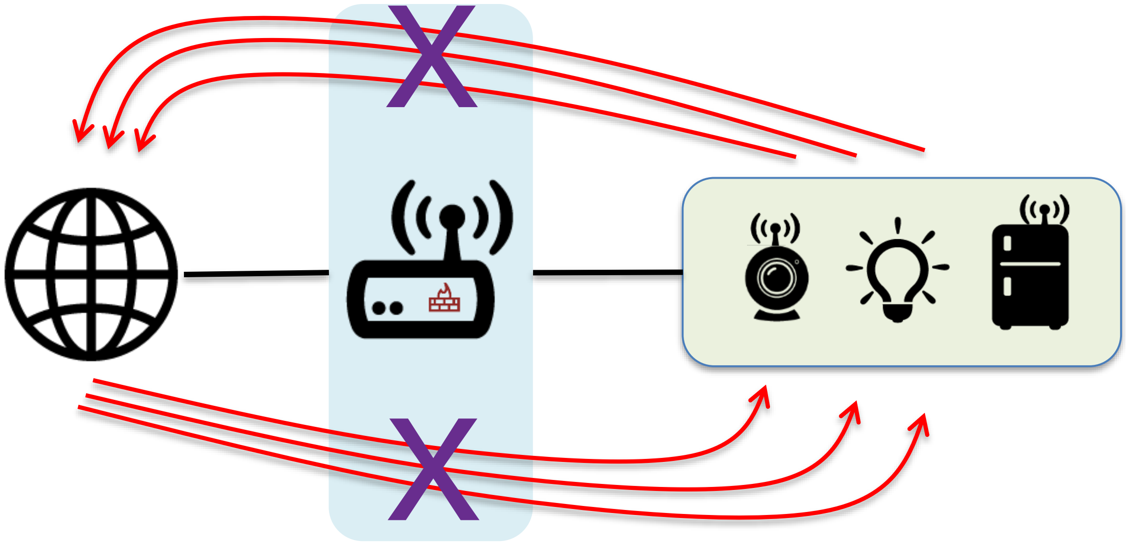
Your home network security both internal and external must be protected by using a simple and user friendly model. Typing passwords is a thing of the past.

How did we get here?

- Our assessment of the home network and IoT security posture post MIRAI attack clearly identified a need for **additional home security measures** to protect the internet from compromised IoT devices and a very strong need for an enhanced open source home security framework.
- Our work so far has identified a **significant gaps in open source projects** to implement an enhanced home security framework
- We embarked on a journey to **identify these gaps and start development** of many open source projects to **better the internet** ☺

Secure Home Gateway (SHG)
Primary Project Goal

- The primary goal of this project is to develop a secure home gateway that;
  - **protects** the internet from IoT devices **attacks** and
  - **protects** home IoT devices from the internet **attacks**



Scope of Work and Goals

- We are developing an advanced security framework for small network (home and small business) gateways based on integrating existing and emerging technologies & standards
- Goals:
  - Develop a functional SHG prototype
  - Develop a simple management interface to provision complex network
  - Identify new standards requirements and updates
  - To enhance small network privacy & security with ‘intent based’ network access controls
  - To have open source running code & standards
  - Develop a framework to provision SHG domain names

Why are we working on this?
-> Risk mitigation

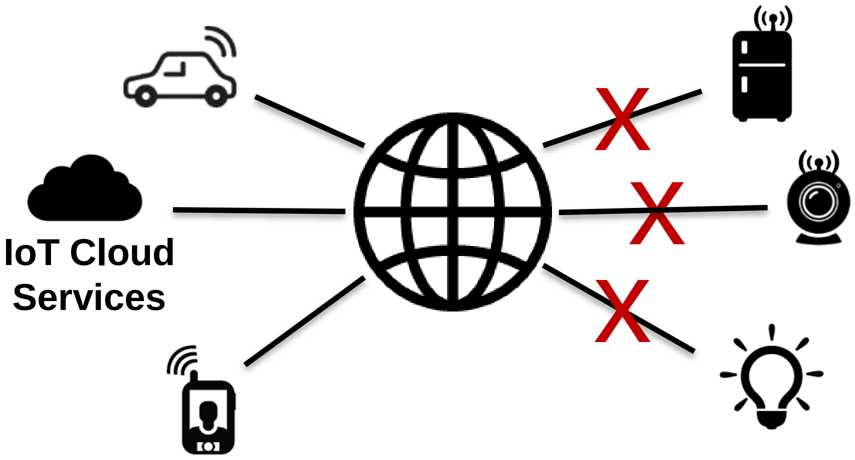
- For many internet organizations like CIRA the #1 risk on the risk register is a large scale (Dyn like) DDoS attack.
- One of the mitigation mechanisms for this risk is to prevent ‘weaponization’ of IoT devices
- Tightly controlling access ‘to’ and ‘from’ IoT devices inside the home or small office network is key to preventing ‘weaponization’ and causing harm on the internet.
- The **threat** that **IoT devices** bring is the **scale of attacks**. The uncontrolled access of million/billions of IoT devices to and from the internet is the threat we need to mitigate.

Overview of the IoT threat landscape -> Scale and capacity

- IoT device compromises:
  - Used in internet attacks i.e. MIRAI/DYN Attack (DDoS) targeting DNS servers (~1.2 Tbs)
- IoT traffic generation, reflection and amplification
  - IoT device used various attacks (DDoS) NTP, DNS, SNMP and new vectors.
  - IoT device have the capacity to generate large traffic load
  - Home and small office network now starting to have gigabit internet access speed, significantly impacting the capacity to create powerful attacks

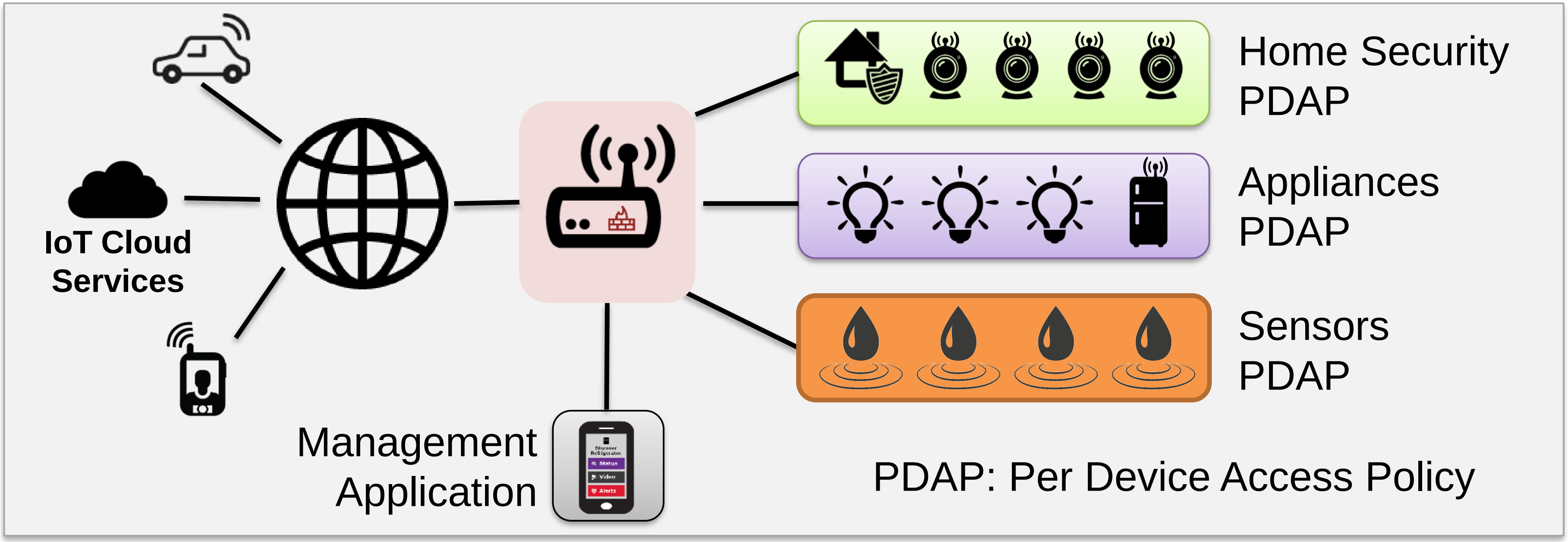
How can we protect IoT devices? -> Common sense

- “Don’t even think of connecting an IoT device directly on the internet”
- Always place IoT device behind a gateway / firewall
- Don’t allow remote access to an IoT device



How can we protect IoT devices?
-> Best practice & new standards

- Rule #1: Identify IoT devices on your home network
- Rule #2: Place a policy around the IoT device that restricts it to a specific function (default is no access)
- Rule #3: Monitor for behavioural changes in the device and quarantine at the first sign of change.



How do we provision new IoT devices? -> Application of emerging standards

- The IETF is working on a Manufacturer Usage Description (MUD) specification to help with IoT device provisioning and automated network access control configuration.
  - https://datatracker.ietf.org/doc/draft-ietf-opsawg-mud

I'm an ACME water sensor

- MUD File at: https://acme.corp/mud/ws1.0.json

MUD FILE:

- I have WIFI & apply the water sensor access policy

Cloud Service - I need to upgrade my firmware at https://acme.corp

Control - Configure me at https://myip/setup

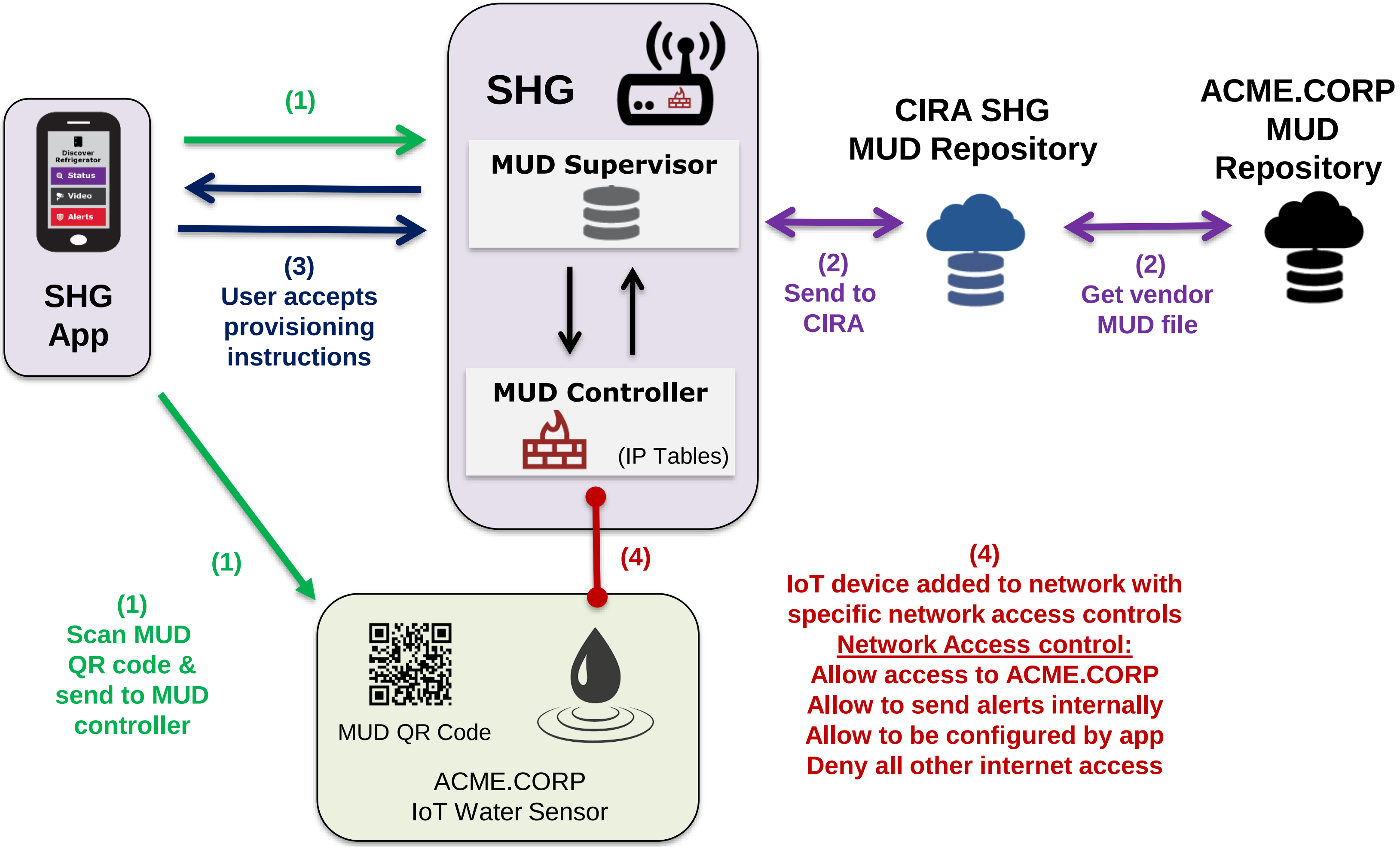
Alerts - Alerts available at https://myip/alerts

Manufacturer Usage Description (MUD) -> A unique device identifier (label)

- The MUD file content would be available on the vendor’s web site (model type and firmware version)
  - https://acme.corp/mud/water-sensor-1.0.json
- The MUD file URL would be available on the IoT device as a QR code or as a network parameter

- **It would be nice** if the IoT device could advertise it’s current firmware version and/or current MUD file URL via WIFI or network connection (DPP, DHCP, LLDP…) on order to setup correct security profile

High Level MUD & IoT Device Provisioning Workflow



SHG App

(1)

(3)
User accepts provisioning instructions

SHG

MUD Supervisor

MUD Controller

(IP Tables)

CIRA SHG MUD Repository

ACME.CORP MUD Repository

(2)
Send to CIRA

(2)
Get vendor MUD file

(1)

(1)
Scan MUD QR code & send to MUD controller

(4)

MUD QR Code

ACME.CORP
IoT Water Sensor

(4)
IoT device added to network with specific network access controls

Network Access control:

Allow access to ACME.CORP
Allow to send alerts internally
Allow to be configured by app
Deny all other internet access

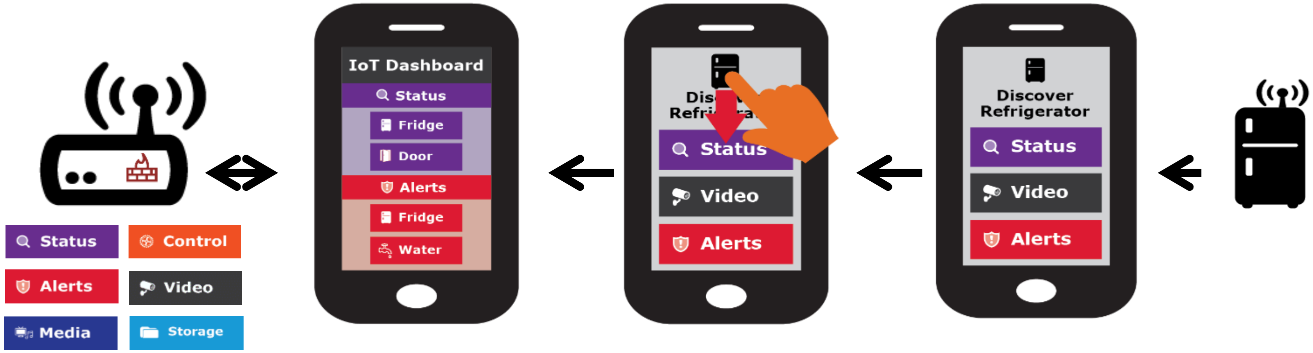
DEMO

https://www.youtube.com/watch?v=LauvEBa4Z4s&feature=youtu.be

You guess it! That’s why we need a **simple provisioning interface** this stuff is complex!

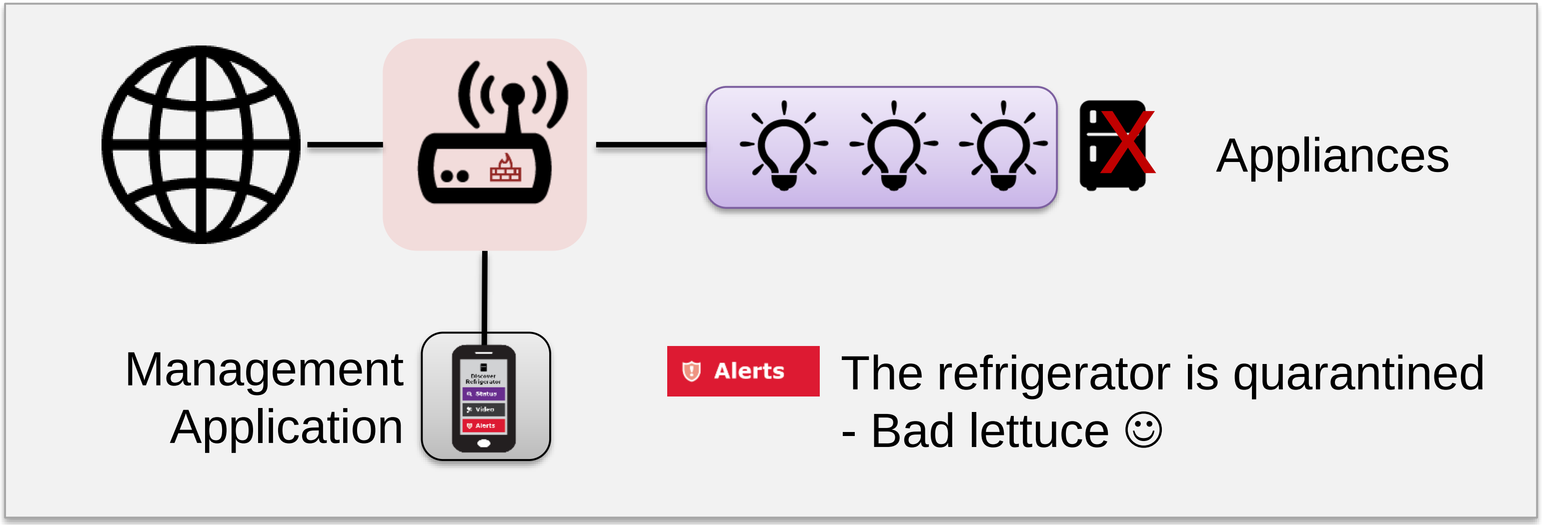
Removing End User Complexity
-> Simple user interface

- The previous slides have outlined the high level workflow. The actual workflow and automation can be very complex.
- One key goal of this project is to present the users with very simple choices to **provision** and **administer** a potential complex network.
- Ideally, the user can only swipe up, down, left and right.



Quarantine of compromised devices -> Behavioural analysis

- The policy part of the MUD profile is created to provide an additional level of protection for the network. This ensures the device will function only as intended and once behavioural changes are noted then the device is logically segregated from the network (quarantine)



Appliances

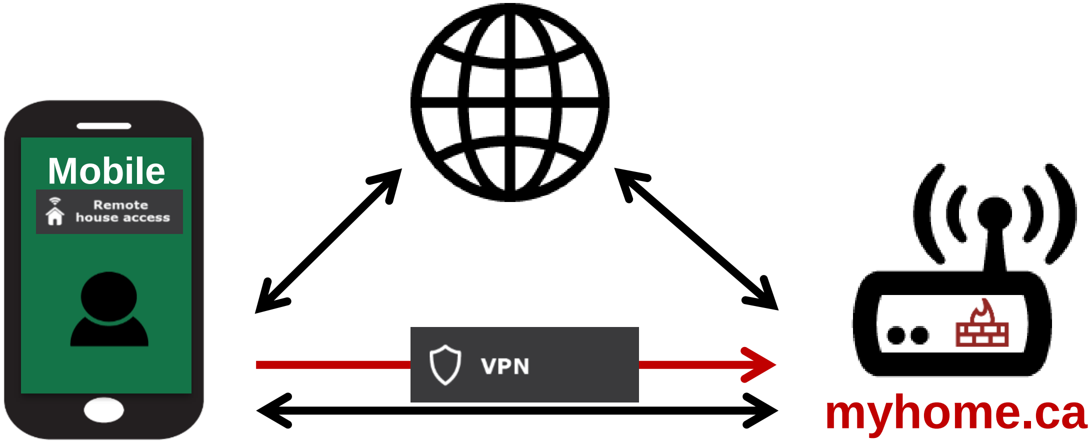
Management Application

Alerts

The refrigerator is quarantined - Bad lettuce ☺

Secure Remote Access
-> Trusted authentication & accessible

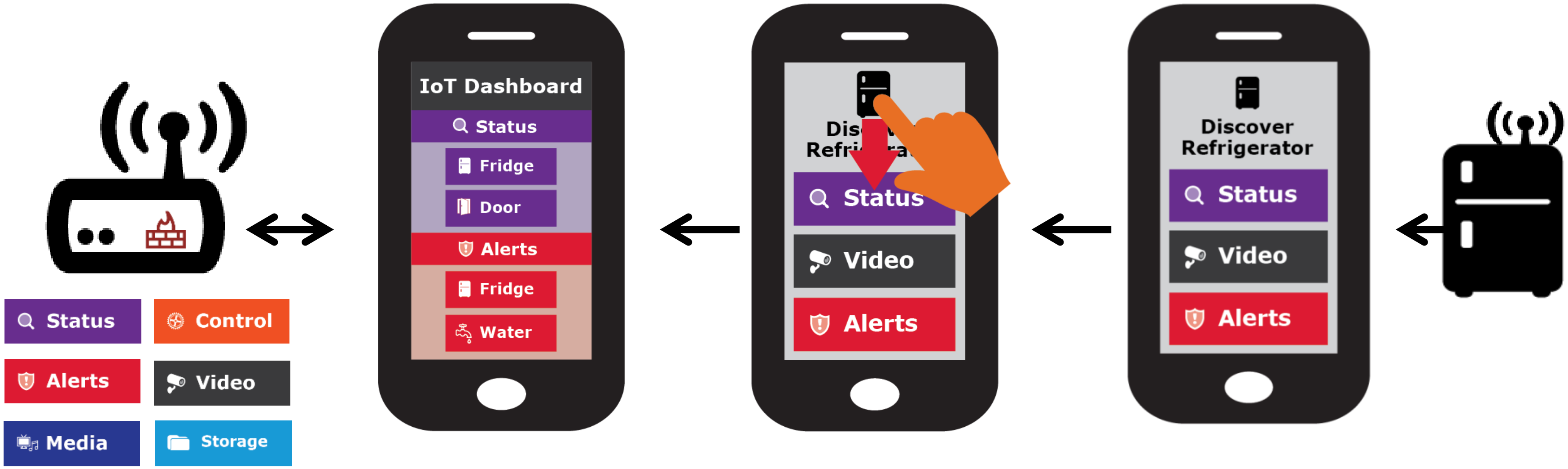
- Removing the complication surrounding enabling trusted secure remote access to home network is a key goal of this project (not for the initial prototype)
- Need an internet resolvable domain name for the SHG to remotely connect. i.e. **"myhome.ca"**



The prototype will use securehomegateway.ca 3rd level domains

Simple user interface is key to this project: **Swipe UP, DOWN, LEFT and RIGHT**

- Gateway provisioning, device discovery, device provisioning must be as simple as possible, intuitive for non experienced users, available as framework for default open source app.



We are building a Prototype
-> Based on Omnia Turris Gateway

- Develop a Proof of Concept and prototype
  - Using .CZ Omnia Home Gateway & openWRT
  - IoT device provisioning based on MUD
  - Home Gateway App (Android/iPhone)
  - Develop some IoT discoverable devices and MUD profiles
- Use public GitHub to document the functional specification and repo for prototype software
  - Functional specification (Work in progress)
  - Open source software repository
  - **https://github.com/CIRALabs/Secure-IoT-Home-Gateway**

Specifications we are currently leveraging

Specifications we are leveraging:

- https://datatracker.ietf.org/doc/draft-ietf-opsawg-mud/
- https://datatracker.ietf.org/doc/draft-ietf-netmod-acl-model
- RFC 7368
- RFC 8375
- https://datatracker.ietf.org/doc/draft-ietf-homenet-simple-naming
- https://datatracker.ietf.org/doc/draft-ietf-homenet-front-end-naming-delegation
- RFC 4033,4034,4035 (DNSSEC)
- https://datatracker.ietf.org/doc/rfc5011/
- RFC 4795

Specifications we are planning/considering:

- RFC4301, RFC7296 (IPsec. Considering OpenVPN too)
- RFC8366, https://datatracker.ietf.org/doc/draft-ietf-anima-bootstrapping-keyinfra/
- https://datatracker.ietf.org/doc/draft-cheshire-dnssd-roadmap/
- https://datatracker.ietf.org/doc/draft-ietf-dnssd-hybrid/
- https://datatracker.ietf.org/doc/draft-cheshire-dnssd-roadmap/
- https://datatracker.ietf.org/doc/draft-ietf-dnssd-mdns-relay/

Specifications we are writing:

- - draft-richardson-opsawg-securehomegateway-mud-00
- How we are using,extending, MUD.
- - draft-richardson-anima-smartpledge-00
- How we will leverage a DPP-like QR code to do initial enrollment of the *ROUTER*

What do you think?

Project Information
https://github.com/CIRALabs/Secure-IoT-Home-Gateway

Prototype code
https://github.com/CIRALabs/